JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 33 MARCH 15, 1943 No. 3

BOTANY.—*The travels of Thomas Coulter, 1824–1827.*[1] ROGERS MCVAUGH, Bureau of Plant Industry. (Communicated by B. Y. MORRISON.)

Dr. Thomas Coulter, an Irish botanist[2] who lived and traveled in Mexico from 1825 until about 1834, made large collections of herbarium specimens and less extensive collections of living plants, especially of cacti. The most detailed published account of Coulter's life and work in Mexico is that by Coville (1895). The Mexican collections comprised more than 50,000 specimens, according to the brief biographical sketch of Coulter published the year after his death (Romney Robinson, 1844). The herbarium specimens were distributed, after Coulter's death, from Trinity College in Dublin; before distribution they were assigned numbers according to their supposed systematic position, the numbers probably totaling about 1,700. Some of the replicate sets were distributed to American herbaria, the most nearly complete ones now being found at the Gray Herbarium and in the Torrey Herbarium at the New York Botanical Garden. All the Coulter specimens in American herbaria, however, seem to lack data relative to the time and place of collection, having been distributed under the numbers assigned at Dublin but without any other notations. The "first set" of the collection, according to Coville, went to the herbarium at Kew, and many of the specimens were cited, with collection number and locality, by Hemsley in the botany of the *Biologia Centrali-Americana* (1879–1888). As pointed out by Coville, little has been published concerning the details of Coulter's travels in Mexico, and the specimens cited by Hemsley have remained the chief source of information on this score. The present paper contains an account of the botanist's itinerary from the time of his departure from London, in September, 1824, until October, 1827. This account has been drawn up from Coulter's own notebook, lent by his nephew, Joseph A. Coulter, to Dr. F. V. Coville, and now on deposit in the files of the Division of Plant Exploration and Introduction, Bureau of Plant Industry.

Most of the notes taken by Thomas Coulter in Mexico are those relative to his observations while traveling; he carried a compass, sextant, barometer, thermometer, and two chronometers and recorded all the details of his instrumental data and his calculations thereon. Although evidently much interested in the plants and animals he saw, he did not write of any collections he may have made but confined himself to brief notes upon the places he visited and occasional comments upon his experiences. His entries were made at irregular intervals except when he traveled, when he seems to have been careful to record the movements of each succeeding day. He was employed by the Real del Monte Mining Co., and his travels took him to the several areas in which they had interests. Landing at Veracruz on January 28, 1825, he went as rapidly as possible to Real del Monte. After some months spent there (except for two trips to Mexico City) he traveled up the old highway to Zacatecas, where he stayed more than a year, making in the meantime one trip to the mines at Bolaños, Jalisco. Leaving Zacatecas in January, 1827, Coulter made his way to the mining district at Zimapán, Hidalgo, where he made his headquarters at least until October of that year. He seems to have made few collections while traveling, if one may judge by the numbers

[1] Received November 21, 1942.
[2] Born 1793, died 1843.

of specimens cited by Hemsley; approximately 300 numbers are cited from Zimapán, nearly 150 from Real del Monte, and nearly 50 from Zacatecas, but no more than 15 in all from along the routes connecting these places. This may have been due in part to the exigencies of travel by mule, as noted by Ward (1828, p. 316): "In Mexico, you never stop upon the road to bait, but perform the whole distance, whatever it may be, without a halt. It is better for the horses and mules, as they have a longer time together for rest and food, which, in so hot a climate, they do not enjoy without water, and this cannot be given them, in any quantity, until the day's work is done."

The first entry in Coulter's notebook is dated, at London, August 18, 1824, and is followed in the next few weeks by several having to do with the regulation of the chronometers. On September 21 Coulter boarded his ship, the *Thalia*, and on the next day she sailed from Gravesend. She reached Funchal, Madeira, on October 13 or 14 and left again on November 5. Antigua was sighted on November 29, and on December 8 the ship came to anchor off Port Maria, Jamaica. Coulter found it impossible to take his baggage overland to Kingston, so obtained passage in a small boat and reached Kingston on the 14th.

At Kingston, through a gentleman whom he had known previously in Ireland, Coulter secured permission to continue his trip on the British ship *Primrose*, which carried the mails to Veracruz, and left Jamaica on January 6, 1825. On January 27 the ship came to anchor just south of Veracruz, and the next day Coulter passed the customs and received his passport at Mocambo. His experiences for the next few days may be told in his own words:

> Friday Feby. 4th. 1825 I have not got mules before today. Set out at four oclock. As far as Xalapa, which we reach on the 8th (five days) the road lies thro' the *tierras calientes*—& as the country is rather flat, with a good deal of wood, we see but little of it—We rest a day (9th) at Xalapa—I make the acquaintance [of] the Count de Sache (is it so he spells it) who is travelling here to collect—& go out a shooting with his aide [whom Coulter calls Ferd. Deppe de Berlin].
>
> Feby. 10th Proceed. from Xalapa the road ascends rapidly, but is good. The scenery exceedingly alpine but this ceases in one day. We sleep at La Joia—& may now consider ourselves on the tableland. [La Joia, 6 or 7 miles northwest of Jalapa, appears on Humboldt's (1812) map as "La Hoya"; Ward (1828, p. 196) uses the latter spelling; a nearby mountain appears as "La Jolla" on Ward's maps.]
>
> Feby. 11th At La Cruz Blanca we quit the great road to Mexico & take to the Steppe, passing at first thro' a fine forest of pines & sleep at Sierite Leonce [spelling?].

On the 12th the party passed Santa Gertrudis, on the 13th Virreyes, on the 14th "St. Miguel Franco," and on the 16th Santa Buenaventura. The route for these five days was at first southwest, then northwest, approximately along the course now followed by the Ferrocarril Interoceánico. Humboldt shows the route between Jalapa and Franco, which is apparently the "St. Miguel Franco" of Coulter; La Cruz Blanca, or Cruz Blanca, is about 10 miles northeast of the modern Perote, Veracruz; Sierite Leonce is apparently near the Cerro de León, about 6 miles southwest of Perote. Near this point, or about 6–7 miles southwest of Perote, Coulter's road forked; Santa Gertrudis lay on the more northern road, about 2 miles from the fork. Beyond Virreyes, in the state of Puebla, the road turned again to the northwest; Franco is in eastern Tlaxcala and Santa Buenaventura is in the northwestern part of the same state. Coulter continues:

> 17th Pass Apan [i.e. Apam, Hidalgo] & stop at an Hacienda—good horses here but dear—(Talahiote) [i.e. Tlalayote, Hidalgo]. We have now been seven days on the steppe with hills on each side of us—& might still continue on it to Tulancingo—but take a shorter road to Real del Monte.
>
> 18th After a league of plains we take to the mountains—& reach a considerable pueblo on the borders of a pretty large plain. 19th reach Guajolote, on the companys possessions. Sunday, Feby. 20th, 1825. Real del Monte.

On leaving Apam, Coulter seems to have doubled back to the east to reach Tlalayote, then turned to the northwest before reaching Tulancingo. Guajolote is 8 or 10 miles east of Pachuca, Hidalgo.

Real del Monte (often appearing on modern maps as Mineral del Monte) was an ancient mining center, the site of some of the workings of the Real del Monte Mining

Co., with whom Coulter had a 3-year contract as medical attendant. At the mine he made his headquarters for some months. The entries in his diary were made here at various times from February 20 until April 16. On this latter date he left for Mexico City, sleeping at San Mateo and reaching the capital on the 17th. He stayed in Mexico at least until the 27th, but on the 29th he was back in Real del Monte, where he stayed until June 15. From June 17 to June 28 he was in Mexico again, and from June 30 until October 31 the entries indicate that he was at Real del Monte more or less continuously.

On October 31, 1825, Coulter began what was to be a three weeks' trip to Zacatecas. His daily entries during this trip give his movements in the minutest detail; he attempted to fix his position at intervals each day by means of compass bearings on prominent points, by the courses of streams, by barometric readings, and by the estimated distances traveled. The route led westward from Pachuca to Tetepango and Tula, Hidalgo, and thence along the old highway from Mexico to Zacatecas. The details are well shown on Humboldt's maps (1812); the part of the road between Tula and Silao is described by Ward (1828, p. 411 *et seq.*). The itinerary of Coulter's trip, as taken from the entries in his diary, is as follows:

1825

Oct. 31. Real del Monte to Pachuca, Hidalgo.
Nov. 1. Pachuca to Tetepango, Hidalgo.
2. Tetepango, via the pueblo of San Pedro and via Tula, to San Antonio, Hidalgo.
3. Remained at San Antonio.
4. San Antonio to Arroyo Sarco [i.e., Zarco], México.
5. Arroyo Zarco to San Juan del Río, Querétaro.
6. San Juan del Río to the city of Querétaro.
7. Remained at Querétaro.
8. Querétaro to Celaya, Guanajuato.
9. Celaya to Salamanca, Guanajuato.
10. Salamanca to Hacienda de Burras [i.e., Burras], Guanajuato, via Santa Rosa and Jarapitio.
11. Hacienda de Burras to the city of Guanajuato, via Marfil. During the day Coulter spent some time at the Valenciana mine, northeast of the city.
12. Guanajuato to Silao, Guanajuato.
13. Silao to León, Guanajuato.
14. León to Lagos, Jalisco [sometimes called Lagos de Moreno].
15. Lagos to Mesón de Sauces, "a wretched place." This hostelry, which appeared on some contemporary maps of Mexico simply as "Inn," was known to Humboldt as "Venta de los Sauces," and stood at the point where the road turned from its northwesterly course from Lagos to run almost due north to Aguascalientes.
16. Mesón de Sauces to Aguascalientes.
17. Aguascalientes to the hot springs and return.
18. Aguascalientes to Rincón de Romos, Aguascalientes.
19. Visited a long-abandoned tin mine, 1 league west of Rincón; left Rincón after noon; at 4:15 was a league north of La Punta, and at 5:20 stopped at an unnamed hamlet [apparently near the northern boundary of the state of Aguascalientes].
20. Continued to Soquité [i.e., probably Zóquite, a few miles southeast of the city of Zacatecas].
21. Zóquite to Veta Grande, Zacatecas.
22. Veta Grande to Zacatecas.
23. Zacatecas to Veta Grande.

The mines at Veta Grande, north of the city of Zacatecas, were taken over by the Bolaños Mining Co. in 1825, according to Ward (1828). Coulter made his headquarters at Veta Grande for more than a year and for most of that time was in partial or complete charge of actual mining operations (Romney Robinson, 1844; Ward, 1828, p. 628–629); his connection with the Bolaños Co. is not clear, although its director, a Captain Vetch, was also the director of the Real del Monte Co. (Ward, 1828).

From the time of his arrival until December 12, 1825, Coulter seems to have remained at Veta Grande. From Friday to Sunday, December 2 to 4, he reported a cold snap, with the minimum temperatures ranging between 16° and 20° F. On December 8 he says: "The Maguays have suffered but very little by the hard frost of Friday to Sunday last—Those only that were about flowering seem a little nipped. They however do not thrive well here—are scarcely cultivated." Temperatures at Veta Grande for December 2, 3, 4, 6, and 12, 1825, were later reported by Coulter in his *Notes on Upper California* (1835).

On the 12th Coulter began a hurried journey to Bolaños, Jalisco, to attend a Mr. Martin who was ill of a fever. Leaving at 7:30 P.M., he reached Xeres [i.e., Jerez, now Ciudad García, about 25 miles west-southwest of Zacatecas] at 4 the following morning—with the temperature at 12° F.—and continued to Santa María, which he reached the same night. Starting early the morning of the 14th, he reached Bolaños at night. He stayed at Bolaños until Christmas night; of his start on the return journey he says: "That I might not travel on a Sunday I spend the evening at a ball in the priest's & at midnight start on my return to Zacatecas." On December 28 he proceeded from Tlaltenango, Zacatecas, to Colotlán, Jalisco; on the 29th he went from Colotlán to Villa Nueva, Zacatecas, and on the 30th he reached the city of Zacatecas.

After his return from Bolaños Coulter seems to have spent most of the year 1826 at Zacatecas (more accurately, at Veta Grande, where he lived), but the entries in his notebook are few. (The entries are dated January 12, February 23 and 24, April 9 and 16, May 14, June 11.) Ward (1828, p. 619) records a visit to Zacatecas, December 21 to 26, 1826, and comments upon the hospitality shown him by Coulter at this time.

The entries in the notebook are nearly complete for the first months of the year 1827. Coulter left Zacatecas on Monday, January 15, enroute for the mines at Zimapán, Hidalgo. His way is easily followed, but many of the ranches and haciendas at which he stopped are not to be found on modern maps. His direction of travel was generally southeast:

1827

Jan. 15. Started for Sauceda and reached El Refugio, Zacatecas; his day's journey was some 20 miles, made in 5½ hours.
16. Reached Buenavista in about 6 hours.
17. Reached Ciénaga Grande in 8 hours.
18. Reached Letras in 7½ hours.

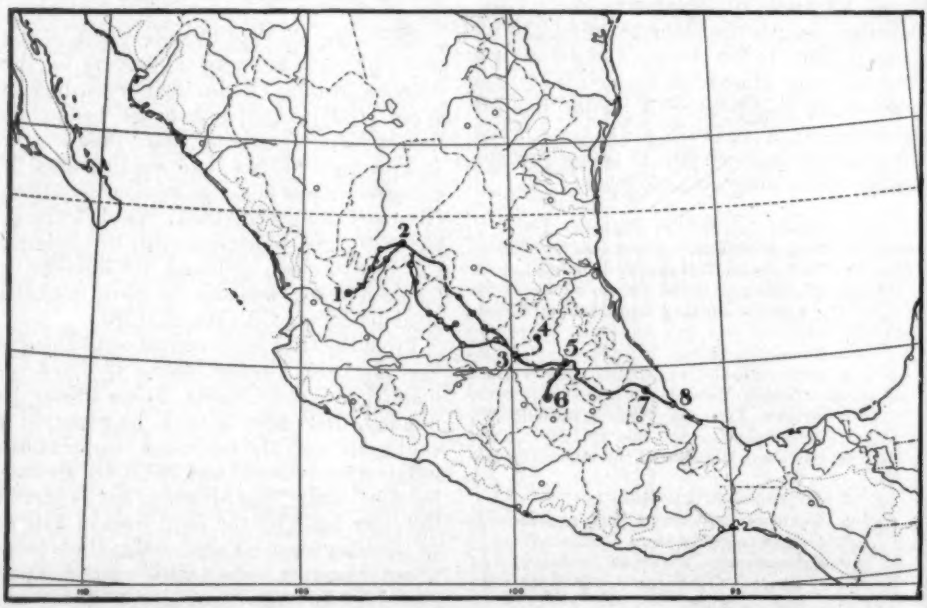

Fig. 1.—The routes followed by Coulter in Mexico, 1825–1827. The circles along the routes indicate the principal places, and solid dots indicate localities at which Coulter is known to have collected plants. Broken lines indicate uncertainty as to the exact route followed. The numbered localities are as follows: 1, Bolaños, Jalisco; 2, Zacatecas, Zacatecas; 3, San Juan del Río, Querétaro; 4, Zimapán, Hidalgo; 5, Real del Monte, Hidalgo; 6, México, D.F.; 7, Jalapa, Veracruz; 8, Veracruz, Veracruz.

Jan. 19. Reached Ojuelos in 6 hours. This appears to be the Ojuelos in the northeastern corner of the state of Jalisco, but Coulter's route there from Zacatecas is not entirely clear. A manuscript map in the British Museum (B.M. additional ms. 17659A, "Mapa del Reyno de Nueva Galicia Año de 1812," photostat copy in the Library of Congress) shows Letras (a Ranchería) about 5 miles northwest of Ojuelos, and Ciénaga Grande (an Hacienda) about 20 miles west of Ojuelos. On the same map appear two haciendas called Buenavista; one is about 5 miles northeast of Letras, and the second a few miles north of Sauceda.

20. Reached a rancho near "Sta. Iphegenia" in 8 hours.

21. Reached San Felipe, Guanajuato, in 4 hours.

22. Remained at San Felipe.

23. Reached La Quemada, Guanajuato, in 4½ hours. From San Felipe to San Miguel he was apparently following the regular route from San Luis Potosí to Mexico City.

24. Stopped to shoot, apparently in the vicinity of La Quemada.

25. Reached Dolores [i.e., Dolores Hidalgo], Guanajuato.

26. Dolores to San Miguel el Grande [i.e., San Miguel of modern maps], Guanajuato, passing Atotonilco about noon.

27. San Miguel to Rancho de los Ricos, in 4½ hours. "Rancho de los Ricos" is apparently the place appearing on some maps as Ricos, near the eastern boundary of Guanajuato, about 15 miles south of east of San Miguel.

28. Passed through Chichimequillas, Querétaro (about 10 miles northeast of the city of Querétaro) and reached Hacienda de Mascala [i.e., probably Amascala, Querétaro, about 5 miles southeast of the city].

29. Reached San Juan del Río, Querétaro.

30. Remained at San Juan del Río.

31. Reached Huichapa [i.e., Huichapán], Hidalgo, in 9 hours. At San Juan del Río he left the road to Mexico and turned eastward.

Feb. 1. Huichapán to La Bahía in 7 hours.

2. La Bahía to Zimapán, Hidalgo. The route followed is not entirely clear, as La Bahía seems not to appear on modern maps of Hidalgo. Coulter left La Bahía at 7 A.M., reached the edge of the barranca of the Río Tula at 9:45, crossed the river by the bridge about noon, and reached Zimapán at 6 P.M. His note says that he passed "by left (S) of San Juanico," so it is probable that he crossed the river either at Izmiquilpán or at Tula, the latter being the site of one of the few bridges over the Río Tula. If he then followed a course more or less parallel to the river, he must have passed to the south and west ("left") of San Juanico.

The notebook contains entries dated at Zimapán, February 4, 5, 11, and 24, and one final entry dated October 11, 1827. In Coulter's *Notes on Upper California* he reports observations made at Zimapán between April 8 and 15; this presumably refers to the year 1827 or to a later year, for at the same time in 1825 he was in Real del Monte, and in 1826 at Veta Grande.

The date of Coulter's departure from Zimapán is unknown, but it may have been at the expiration of his 3-year contract, either late in 1827 or early in 1828. In the early part of the latter year he sent to A. P. DeCandolle a shipment of living cacti, which the latter reported upon at a meeting on July 22, 1828. Forty-seven species were described as new, so that at least a short time must have elapsed between their arrival in Europe and their presentation by DeCandolle (DeCandolle, 1828). Allowing time for their passage across the Atlantic by sailing vessel, we may fix the time of their dispatch from Veracruz at about the first of May, or perhaps earlier. One may suppose that the shipment had been gathered by Coulter during the closing months of his stay at Zimapán and sent abroad upon the completion of his work there.

Almost nothing is known of Coulter's life and activities between the time of his departure from Zimapán and that of his arrival in California, late in November, 1831. He is known to have been in Sonora, in the vicinity of Hermosillo, in December, 1829 (Coville, 1895), and from the specimens cited by Hemsley it seems that he made at least one trip from San Blas, the seaport of Tepic, Nayarit, along the old highway through Tepic to Guadalajara; specimens labeled "San Blas to Tepic" or "San Blas to Guadalajara" are occasionally cited. He is also known to have collected at Guaymas,

Sonora, and at Mazatlán, Sinaloa, and may well have spent much of the period from 1827 to 1832 in mining centers in the western states of Mexico. If one may judge by the specimens cited by Hemsley, Coulter collected very few plants in western Mexico. From Zimapán, as pointed out above, approximately 300 species are listed in the *Biologia Centrali-Americana;* from Real del Monte almost 150 species are noted, and from Zacatecas about 50. From all western Mexico together, however, scarcely 75 specimens are cited, and more than half of these are from "Sonora Alta," which may refer to the region about Guaymas or to the region about Yuma visited by Coulter in 1832.

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BOTANY.—*Four new species of Acanthaceae from Guatemala.*[1] E. C. LEONARD, U. S. National Museum. (Communicated by WILLIAM R. MAXON.)

Recent studies of the Acanthaceae of Guatemala, especially of material collected by Julian A. Steyermark on the 1939–40 expedition of the Field Museum of Natural History to that country, have resulted in the recognition of four new species described herewith.

Dyschoriste skutchii Leonard, sp. nov.

Herba, caulibus puberulis; lamina foliorum ovalis vel suborbicularis, apice obtusa vel rotundata basi angustata, parce hispidula; petioli tenues; inflorescentia subcapitata, terminalis, bracteis oblanceolatis; calyx glaber vel parce hirsutus, segmentis subovatis; corolla lilacina, minute pubescens; ovarium glabrum.

Stems usually numerous, prostrate, erect or ascending from a short woody base, puberulous, the hairs retrorsely curved, white, the roots thick-fibrous; leaf blades oval to suborbicular, up to 18 mm long and 14 mm wide, obtuse or rounded, cuneate at base, bright green, darker above, sparingly hispidulous (the larger hairs confined to costa and veins), sometimes ciliate toward base, the costa and veins (usually 4) prominent; petioles slender, up to 3 mm long, more or less puberulous, sometimes ciliate; flowers crowded in heads at the tips of the branches; bracts oblanceolate, somewhat smaller than the leaves but resembling them in most respects; calyx up to 13 mm long, the tube 3 mm long, glabrous or sparingly hirsute, the segments subulate, hirsute, the hairs white, spreading, up to 0.75 mm long, but gradually shorter and very minute toward the bristle-like tips of the lobes; corolla lavender, minutely and inconspicuously pubescent, about 13 mm long, the narrow portion of the tube about 5 mm long and 1.5 mm in diameter at base, narrowed to 1 mm just above base, thence gradually expanded to 4 or 5 mm at throat, the limb about 8 mm broad, the lobes rounded; stamens 3 and 4 mm long, the anthers ovate, the minute white mucronate tips of their basal lobes slightly divergent; ovary glabrous; mature capsules not seen.

Type in the U. S. National Herbarium, no. 1586098, collected on an open hillside near Tecpam, Department of Chimaltenango, Guatemala, altitude 2,100 meters, July 22, 1933, by A. F. Skutch (no. 474). *Lehmann* 1524 from Huehuetenango, Guatemala, altitude 1,500 meters, and *Steyermark* 33063, collected on dry slopes of pine woods just southwest of Minas de Croma, Department of Jalapa, Guatemala, are also this species.

Dyschoriste skutchii is related to *D. capitata* (Oerst.) Kuntze but is amply distinct in its oval or suborbicular leaves and in its puberu-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 15, 1942.

lous stems. In *D. capitata* the leaves are obovate and the stems pubescent, with longer and more spreading hairs. The latter species seems to be limited to southern Mexico.

Dicliptera vulcanica Leonard, sp. nov.

Frutex, caulibus parce pilosis; lamina foliorum ovata, breve-acuminata, basi obtusa vel acuta, in petiolum decurrens, parce hirsuta; petioli tenues, pilosi; cymae pedunculatae; bracteae floriferae herbaceae, pilosae, puberulae, bractea posterior linearis, anterior oblanceolata; bracteae laterales angusto-lanceolatae vel subulatae, chartaceae, puberulae; calycis segmenta lanceolato-subulata, papillosopuberula et pilosa; corolla subrufa, pubescens, labio superiore leviter emarginato, minute apiculato, inferiore oblongo, trilobo, lobis parvis, rotundatis; capsulae parvulae; semina plana, orbiculata, fulva, minute verrucosa.

Shrub up to 2 meters tall; stems sparingly pilose, the hairs white, spreading or retrorsely curved, up to 1 mm long, more or less arranged in 2 lines, or the lower portions of the stems glabrous; leaf blades ovate, up to 10 cm long and 5 cm wide, short-acuminate (the tip blunt), acute or obtuse at base and decurrent on the petiole, thin, drying dark green, sparingly hirsute, the hairs spreading, 0.5 to 1 mm long, confined chiefly to costa and veins (6 or 7 pairs); petioles slender, up to 2.5 cm long, pilose; flowers borne in axillary peduncled cymes (3 flowers in each cluster), the peduncles up to 6 cm long, sparingly pilose, usually branched at tip, each bearing 3 to 5 stalked flower-clusters; bracts subtending the secondary peduncles subulate, up to 5 mm long, pilose, the pair of outer floral bracts herbaceous, both pilose and puberulous (at least some of the hairs glandular), the posterior one linear, about 10 mm long and 1.5 mm wide, acute, the anterior one oblanceolate, 13 mm long and 3.5 mm wide, acute, the interior floral bracts narrowly lanceolate or subulate, up to 8 mm long and 1 mm wide, chartaceous, puberulous, the hairs papilliform; calyx 7 to 8 mm long, the tube subglabrous, the segments about 6 mm long, lance-subulate, 1 mm wide at base, thence gradually narrowed to a slender tip, the pubescence a mixture of minute papilliform hairs and longer pointed ones; corolla 33 mm long, dull reddish, finely pubescent, the tube about 13 mm long, the lower portion about 3 mm broad for 8 mm of its length, thence gradually and somewhat obliquely enlarged to 6 mm at throat, the posterior lip oval, about 6 mm wide, rounded, shallowly emarginate and minutely apiculate, the anterior lip oblong, about 5 mm wide, the 3 lobes rounded, about 1 mm long and wide or slightly wider, the middle one ciliate; capsule 12 mm long, 5 mm broad, puberulous; seeds flattened, orbicular, 3 mm in diameter, brown, minutely verrucose, or smooth with age.

Type in the herbarium of the Field Museum of Natural History, no. 1045321, collected at base of barranca along stream between Tajumulco and Loma Buena Vista, on the northwestern slope of Volcán Tajumulco, Guatemala, altitude 2,300 to 2,800 meters, February 28, 1940, by Julian A. Steyermark (no. 36861); isotype in U. S. National Herbarium, no. 1820956.

This well-marked species is characterized by the thin hirsute leaf blades, the peduncled cymes, and the peculiar minute papilliform hairs of the calyx and bracts.

Odontonema steyermarkii Leonard, sp. nov.

Frutex glaber; lamina foliorum ovata vel oblonga, acuminata, basi angustata, in petiolum decurrens; panicula parce ramosa; bracteae subulatae, ciliolatae; pedicelli tenues; calycis segmenta subulata, parce puberula; corollae tubus pallide ochraceus, lobis lilacinis, ovalibus, rotundatis; ovarium glabrum.

Glabrous shrub up to 2 meters high; leaf blades ovate to oblong, up to 18 cm long and 8 cm wide, acuminate (the tip blunt), narrowed or rounded at base and decurrent on the petiole, the costa and veins prominent; petioles up to 3 cm long; inflorescence a sparingly branched panicle, the flowers borne in umbels of usually 3 to 6 flowers each, the lowermost of these peduncled (5 mm long, successively shorter toward tip), the uppermost sessile; bracts subtending the peduncles subulate, 1.5 mm wide at base, gradually narrowed to a slender tip, ciliolate, those subtending the umbels similar but slightly smaller; pedicels slender, up to 6 mm long; calyx 3.5 mm long, the segments subulate, about 3 mm long and 0.5 mm wide at base, sparingly puberulous toward tip; corolla up to 24 mm long, 2 mm in diameter at base, narrowed about 5 mm above base to 1 mm,

thence enlarged to about 4 mm at throat, the tube pale buff, the lobes lilac, oval, 5 mm long and 2.5 mm wide, rounded at tip; ovary glabrous; fruit not seen.

Type in the Herbarium of the Field Museum of Natural History, no. 1046653, collected along road between Finca Pirineos and Calahuaché, Department of Quezaltenango, Guatemala, altitude 1,200 to 1,300 meters, January 27, 1940, by Julian A. Steyermark (no. 35020); isotype in the U. S. National Herbarium, no. 1820953.

This species may be recognized by its narrow, sparingly branched panicles of flowers, which are said by the collector to be pale buff and lilac.

Odontonema galbanum Leonard, sp. nov.

Frutex, caulibus glabris vel parce et minute pubescentibus; lamina foliorum oblonga, longe acuminata, basi angustata, plus minusve falcata; panicula angusta, terminalis; bracteae subulatae, glabrae; calyx glaber, segmentis subulatis; corolla glabra, galbana, labio superiore bilobo, lobis parvis, rotundatis, ciliolatis, inferiore trilobo, lobis ovalibus, parce ciliolatis; ovarium glabrum.

Shrub up to 2 meters high; stems glabrous or sparingly and minutely appressed-pubescent; leaf blades oblong, up to 36 cm long and 5.5 cm wide, long-acuminate (the tip often curved), gradually narrowed at base, rather thin, veiny, the costa and lateral veins (usually 10 to 12 pairs) fairly prominent; inflorescence a narrow terminal panicle 20 cm long, the flowers borne in small sessile or subsessile umbels, the pedicels up to 5 mm long, these and the rachis glabrous; bracts of the rachis subulate, 3 mm long and 1 mm wide at base or less, keeled, glabrous, those subtending the pedicels similar but smaller; calyx glabrous, 2.5 to 3 mm long, the segments subulate; corolla glabrous, greenish yellow, up to 27 mm long, 2 mm in diameter at base, narrowed to 1.5 mm just above base, the throat 3 mm in diameter, the lips 5 mm long, the upper lip 2-lobed, the lobes 1.5 mm long, rounded, ciliolate, the lower lip of 3 oval lobes 3 mm wide, rounded, sparingly ciliolate at tip; ovary glabrous; fruit not seen.

Type in the U. S. National Herbarium, no. 1790033, collected in moist forest near Barranca Hondo, above Lake Lajas, Department of Escuintla, Guatemala, altitude about 1,200 meters, January 31, 1939, by Paul C. Standley (no. 63875). *Standley* 65014, collected at essentially the same locality, is also of this species.

Odontonema galbanum is easy to recognize by its slender glabrous panicle of greenish-yellow flowers.

ENTOMOLOGY.—*Some undescribed species of flies of the genus* Baccha (Syrphidae).[1] F. M. Hull, University of Mississippi. (Communicated by Alan Stone.)

This paper presents descriptions of several species of *Baccha*. These flies were found among material lent for study by Dr. C. L. Fluke, whom I wish to thank for his kind assistance in my study of the genus. The types are in Dr. Fluke's collection. Paratypes where available are in the author's collection.

Baccha boadicea, n. sp.

Related to *gracilis* Williston. Distinguished by the small spot in the center of the wing and by the larger size.

Male.—Length 9.5 mm. Head: face and front shining black, both yellowish-white pubescent along the sides, the former bluish centrally and with yellow pile; the face in profile without tubercle and barely concave beneath the antennae. The pile of the front is dark brown centrally. The antennae are orange, widely black above on the third joint. The vertex is shining black with black pile in front, yellow behind. Thorax: mesonotum shining black, nonvittate, short golden pilose, the humeri brown, the pleura brownish black with yellow pile and pollen, the scutellum shining black with creased rim, short yellow pile and fringe. Squamae pale. Abdomen: elongate, slender, dark brown, the first joint almost black, the third laterally yellow on the base on each side, the yellow extending about two-fifths the length of the segment. Fourth segment obscurely but narrowly yellow basally, its basal pile yellow,

[1] Received November 4, 1942.

its apical pile black. Legs: yellow on the first two pairs, their femora brownish on the basal half or more, their pile yellow. Hind femora and their tibiae, except the narrow bases, brown and black, respectively, their tarsi pale yellow. Wing: pale brown with microscopic slender alula; stigmal cell dark, and a small spot above the small cross vein brown.

Holotype, male. Pinas, Ecuador, 1,506 meters, July 14, 1941, D. B. Laddey. (Fluke collection.)

Baccha vespuccia, n. sp.

Near *papilio* Hull. The abdominal fascia and vittae are differently shaped. Abdomen widest at end of fourth segment.

Male.—Length 8–10 mm. Head: face and front brownish yellow, a shining blackish half circle over the antennae and a black spot on lunula. Antennae orange, the third joint blackish above. Thorax: mesonotum metallic brownish or aeneous-black, with a pair of rather close brown vittae. The humeri, the lateral margins, the post calli and the scutellum are light yellowish brown, the latter with a few black hairs and no fringe. Mesopleurae and pteropleurae orange; pleura posteriorly blackish. Abdomen: spatulate, the apex barely wider than the base, sepia brown, the narrow sides of the first segment yellowish; the second segment is one and a half times as long as wide with, on each side, a diagonal, yellowish fascia meeting in the midline. Third segment with a similar fascia, divided medially and medially expanded, their posterior margins indented. Fourth segment with, on each side, an inverted Y-shaped figure. Fifth with submedial, yellowish vittae and short sublateral vittae narrowly connected basally with the medial ones. Legs: brownish yellow, the hind femora and tibiae dark brown. Wings: entirely dark brown; alulae quite narrow.

Female.—Front with continuous medial vittae; mesonotum with four violet stripes.

Holotype male, allotype female, and one male paratype, Nova Teutonia, Brazil; Fritz Plaumann. (Fluke collection.)

Baccha aurora, n. sp.

Slender, without alulae. Mesonotum dark brown and yellow laterally, with two gray pollinose vittae. Related to *argentina* Curran.

Female.—Length 10 mm. Head: face and front pale yellow, the latter with a linear brown stripe on the upper part and a tiny black dot on lunula. Pile short, sparse, and black. Vertex black with gray pollen. Antennae yellow, the third joint missing. Thorax: mesonotum brassy black, with a pair of widely separated, steel-blue vittae with gray pollen that reach to the scutellum, and a similar median one on the posterior half. Lateral margins, humeri, scutellum, and all of pleura except a posterior black stripe, pale yellow. Scutellum with a few black hairs and three or four black, central fringe hairs. Abdomen: rather slender, the first segment brown, the anterior corners pale yellow with about 10 black setaceous hairs and a few long pale ones. Second segment with the base light brown and a pair of lateral, subquadrate, brownish-yellow spots just past the middle which are narrowly separated above; the remainder of this segment is blackish. Third segment with an obscure, basal, lateral vittate spot. Fourth segment with a large lateral vitta extending from the base to the posterior two-thirds, its posteromedial margin rounded. Fifth segment shining black. Legs: yellow, the hind femora and tibiae pale brown with subapical brown annulus and the tibiae with the middle paler. Hind basitarsi brownish yellow, the remaining joints dark brown. Wing: hyaline; stigmal cell very dark; no alula.

Holotype: female. Villa Rica, Paraguay, August 1939, F. Schade. (Fluke collection.)

Baccha niobe, n. sp.

Related to *placiva* Williston. The pile on the sides of the first segment is long. Wing apex with a spot.

Male.—Length 9 mm. Head: face and front yellow, with a black dot on lunula. Antennae orange; arista dark brown. The pile of the front is black. Vertex black, rather shining. Thorax: mesonotum cinnamon-brown with a violaceous stripe adjacent to the wide yellow margins. Pleura yellow with a golden reflection. Scutellum brownish orange with a few slender brown hairs and no fringe. Abdomen: elongate, slender, the second and third segments cylindrical. First segment orange and brown, the second orange-brown basally, black on the posterior half, shining apically, in the middle with a pair of oblique, leaflike spots that are

narrowly separated above; these spots are margined on all sides by opaque black, the opaque black forming a triangle behind. Third segment similar, the oblique spots and the median black extend narrowly to the base. Fourth segment with small black triangles in the anterior corners and a large, orange spot basally on each side, its medial margins parallel, its posterior margins oblique and serving to extend the spots apically to the lateral margins. Last segment violaceous-black. Legs: yellow, the hind femora brown at base and with a wide, brown preapical band, their tibiae broadly brown through the middle. Wing: light brown, diffusely blackish at the tip, the alula quite narrow but equally developed throughout.

Holotype: male. Palmar, Manabi, Ecuador, 200 meters, April 10, 1941, D. B. Laddey; a paratype male with same data. (Fluke collection.)

Baccha danaida, n. sp.

Related to *sepia* Hull. The first abdominal segment is yellow on the sides, the third segment has a pair of triangles. The cheeks and pleura are wholly dark brown.

Male.—Length 11 mm. Head: face and cheeks yellow; the tubercle and a stripe above are brown; the front is widely black above but yellow on the sides. It is black pilose. Antennae orange-brown, the arista darker. Thorax: mesonotum brassy brown with a pair of wide, prominent, reddish-brown vittae; the lateral margins are yellowish brown. The pleurae are metallic, dark brown, blackish behind, yellowish on mesopleurae and upper sternopleurae. Scutellum light yellowish brown with sparse dark hair and no fringe. Abdomen: spatulate, wide basally, sepia brown, the sides of the first segment yellow with long black hairs, the second has a slender, diagonal, laterally expanded pair of fascia; the third as a pair of central, narrowly separated, triangular spots. The fourth segment has a pair of comma-shaped spots, and fifth a pair of basal, obscure vittae, laterally extended. Legs: first pair brownish yellow; middle femora light brown, their tibiae and tarsi yellowish; hind femora dark brown, their tibiae black, their basitarsi brown basally, its apex and all the remaining segments yellow. Wing: wholly dark brown, stigma narrow.

Holotype: male. Nova Teutonia, Brazil; Fritz Plaumann. (Fluke collection.)

Baccha saffrona, n. sp.

Abdomen with oblique, triangular vittae, wing light brown, alula rudimentary. Related to *scintillans* Hull.

Male.—Length 9 mm. Head: face and front yellow, a black dot on the lunula; antennae orange-brown with blackish arista. Frontal pile long and black. Thorax: mesonotum light reddish brown, the sides yellowish brown. Vittae if present obscured; scutellum yellowish or reddish brown, the whole pleura yellow-brown. Abdomen: slender, subcylindrical, reddish brown on the first segment and base of second, the latter with a pair of oblique, leaflike orange spots near the middle, not meeting above and margined with opaque black. Third segment with similar, longer, more triangular spots, which reach the base of the segment. Base of segment otherwise blackish, blue-green in the lateral corners. Fourth segment with a similar wider spot more widely extended on the base of the segment, the corners and posterior margin of this segment and the whole of the fifth segment, except for a pair of small basal spots, peacock-blue. Legs: deep yellow, the hind femora quite brown at base and subapically, yellow in the middle, their tarsi dark brown except at base and extreme apex, their tarsi deep yellow. Wing: wholly light brown, the stigmal cell darker; the alula quite narrow.

Female.—Similar to the male, spots absent on fifth segment, the blue areas more violet and the apex of the wings with an ill-defined smoky spot, the whole wing pale. This may belong to a different species.

Holotype: male. Palmar, Manabi, Ecuador, April 7, 1941, D. B. Laddey. Allotype, female; two paratypes, males, two females, all same data. (Fluke collection.)

ZOOLOGY.—*A new trichostrongylid nematode from the stomachs of American squirrels.*[1] JOHN T. LUCKER, Bureau of Animal Industry.

The worms described in this paper were collected by L. Wayne Wilson from two squirrels (*Sciurus*) taken near Moorefield, Hardy County, W. Va., in November, 1941. Examination of the specimens revealed that they were trichostrongyloid nematodes, but it was immediately apparent that the males were very unusual, since certain of the bursal rays were observed to be chitinized.[2]

So far as the writer has been able to ascertain, the only trichostrongyloid nematode in which the occurrence of chitinized bursal rays has been reported is *Böhmiella perichitinea* Gebauer, 1932. Travassos,[3] in his extensive monograph on the Trichostrongylidae, agreed with Gebauer,[4] that, except in this genotype, chitinized bursal rays are unknown among the Strongyloidea.

The specimens collected by Mr. Wilson are here described as representing a new species, closely related to *B. perichitinea*, and for it the name *B. wilsoni* is proposed. While not admissible as evidence of zoological relationship, it is nevertheless of interest that both *B. perichitinea* and *B. wilsoni* are stomach worms of rodents. The known rodent hosts of the respective worms are not, however, closely allied species. *B. perichitinea* was found in a nutria or coypú, *Myocastor coypus*, in Germany. Whether it was introduced into Europe with the coypú, which is indigenous to South America, or normally occurs in European rodents is a question that as yet can not be answered, because there appears to be no subsequent report of its occurrence.

Although previously unrecognized, *B. wilsoni* evidently has existed in squirrels in the southeastern United States for many years, since 4 females, undoubtedly the same as *B. wilsoni*, were found by the writer among specimens (U.S.N.M. Helm. Coll. no. 2934) collected by Dr. Albert Hassall from *Sciurus carolinensis* in 1897.

Böhmiella wilsoni, n. sp.

(Figs. 1–17)

Description.—Head small; diameter (40μ to 50μ) approximately the same as that of the adjacent cervical region. Lips absent; oral opening roughly circular; circumoral membrane present (Fig. 4). Amphidial pores and tips of ventrolateral papillae reaching cuticular surface adjacent to outer margin of circumoral membrane. Submedian papillae four in number, single, externally directed, their tips slightly protruding within depressions located slightly posterior to level of circumoral membrane. In *en face* view, semicircular strands of fibrillike nature may be seen extending outwardly from beneath margin of circumoral membrane to base of each submedian papilla; these strands apparently represent complete union and fusion of terminal branches of submedian papillary nerves. Margin of mouth opening apparently bearing superficially a row of extremely minute denticlelike structures which are interpreted as representing a weakly developed corona radiata (Fig. 4). Oral cavity very shallow, saucer-shaped; lining nonsclerotized. Esophagus communicating with buccal cavity by minute triangular opening and with a minute denticle, formed by lining of dorsal sector, protruding through opening into mouth cavity (Fig. 6). Esophagus swollen at anterior extremity; swollen portion histologically differentiated somewhat from tissue of remainder and partially surrounds mouth cavity (Figs. 3, 6). Cuticular covering of dorsal esophageal sector just posterior to minute terminal denticle forming a comparatively large, more or less transversely directed onchium with lumen and orifice at tip, presumably representing opening of dorsal esophageal gland, since a fine duct connecting with the lumen passes posteriorly into the tissue of the dorsal sector; tip of onchium not reaching floor of

[1] Received September 7, 1942.

[2] In this paper derivatives of the noun chitin are used not in the chemical sense but as convenient descriptive terms to indicate the presence in the specified locations of a dense, brownish substance, probably similar to that composing the spicules of trichostrongylins and identical with it in appearance.

[3] TRAVASSOS, LAURO. *Revisão da familia Trichostrongylidae Leiper, 1912.* Mongr. Inst. Oswaldo Cruz no. 1, 512 pp., 295 pls. 1937.

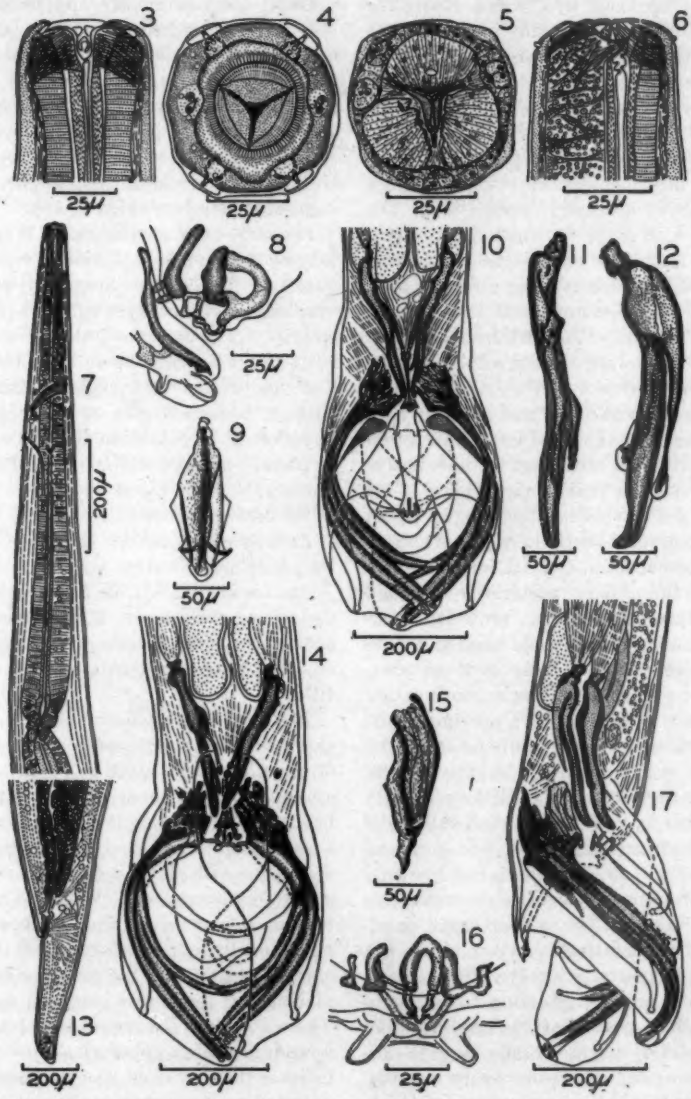
[4] GEBAUER, OTTO. Böhmiella perichitinea *n. sp. ein neuer Trichostrongylide (Nematodes) des Nutria.* Zeitschr. für Parasitenk. 4(4): 730–736, illus. 1932.

buccal cavity (Figs. 5, 6). Cuticular covering of each subventral sector of esophagus at level near base of onchium forming two minute, denticlelike, transversely directed eruptions; also forming rounded hyaline expansions at anterior extremity (Fig. 3). Cervical papillae, large, located slightly posterior to level of nerve ring; excretory pore between level of nerve ring and cervical papillae (Fig. 7). Lateral alae absent; cuticle of mid-body provided with about 50 longitudinal ridges.

Figs. 1–2.—*Böhmiella wilsoni*, n. sp., caudal region of male: 1, Ventral aspect; 2, lateral aspect. (Photomicrographs; magnification approx. ×80.)

Male.—In 3 available specimens 17.1 to 20.3 mm long by 0.21 to 0.24 mm wide just in front of bursa; esophagus, 0.84 to 0.94 mm long; distance from nerve ring and cervical papillae to anterior extremity, 0.32 to 0.35 and 0.43 to 0.45 mm, respectively; length of spicules, 0.300 to 0.321 mm; axial length of gubernaculum, 0.121 to 0.135 mm, length measured along curvature, 0.140 to 0.153 mm.

Prebursal papillae well developed (Fig. 14). Lateral bursal lobes roughly triangular with mediolateral and posterolateral rays supporting apex, originating near median ventral line of body surface a considerable distance anterior to genital cone, and with fine veinlike markings. Cleft between right lateral lobe and comparatively small dorsal lobe only slightly deeper than that between the latter and left lateral lobe (Fig. 10). Ventral rays with common origin; directed posterolaterally for about two-thirds their length, curving anteriorly to bursal margin in their distal one-third, separated and somewhat divergent, but with their tips rather close together (Fig. 14). Ventroventrals smallest rays of lateral lobes, appearing as branches of lateroventrals, the latter having greater flexure than the ventroventrals and being the most robust of the bursal rays (Figs. 10, 14). Laterals with common origin, comparatively slender, directed posterolaterally, except that externolaterals, which are parallel and contiguous to mediolaterals through most of their length, curve anteriorly away from the latter in distal one-third, so that their tips—which do not quite reach bursal margin—are considerably anterior to tips of mediolaterals (Figs. 10, 14, 17). Mediolaterals and posterolaterals equal, parallel, and contiguous, longer than externolaterals and other rays; tips close together, reaching bursal margin. Externodorsals more robust than laterals, but less robust than lateroventrals, apparently originating high up on stem of dorsal, parallel and contiguous to posterolaterals for most of length, but curving anterodorsally away from



Figs. 3–17.—*Böhmiella wilsoni*, n. sp.: 3, Anterior end (female), ventral aspect, optical section through dorsal onchium and two subventral esophageal teeth; 4, head (female), *en face* aspect; 5, optical cross section through esophagus in region of dorsal onchium, aspect in *en face* mount of head; 6, anterior end (female), lateral aspect, optical section through dorsal onchium and two pairs of subventral esophageal teeth; 7, esophageal region (male), lateral aspect; 8, telemon, lateral aspect; 9, gubernaculum, lateroventral aspect; 10, caudal region of male, dorsal aspect (chitinization represented by stippling); 11, right spicule, ventral aspect; 12, left spicule, ventro-lateral aspect; 13, caudal region of female, lateral aspect; 14, caudal region of male, ventral aspect (chitinization represented by stippling); 15, gubernaculum, lateral aspect; 16, telemon, ventral aspect; 17, caudal region of male, lateral aspect (chitinization represented by stippling, to simplify the figure only part of the left lateral lobe of the bursa is shown).

them distally so their tips, which reach the bursal margin, are considerably removed from the tips of the posterolaterals; length about same as externolaterals (Fig. 14). Dorsal ray much shorter than other rays, not asymmetrically located, straight; stem wide, bifurcate in distal one-fourth, each branch typically tridigitate but one may be bidigitate; ventral surface of stem without accessory branch (Fig. 10). Lateral rays with dense brownish chitinization at base and less dense chitinization extending nearly to tips, particularly along margins (Figs. 1, 2, 10, 14, 17). Externodorsal rays usually chitinized at base only (Fig. 10). In lateral view (Figs. 2, 17) chitinized tissues seen to extend internally and anteriorly from bases of these rays towards gubernaculum and anteriorly for a short distance along dorsal body wall, probably representing for most part modification of muscular tissues; in ventral view (Figs. 1, 14) these chitinized extensions appearing as a sort of median transverse bridge in region of spicule tips and gubernaculum. Genital cone with two submedian, thumblike, posteriorly directed processes. Spicules complex, brownish, consisting of complicated proximal knob and alate shaft and terminating distally in three processes, the longest representing a continuation of main shaft (Figs. 11, 12); proximal ends located laterally near body wall and in frontal plane; main shafts extending slightly dorsad and mediad in proximal two-fifths of length and rather sharply ventrad and mediad in distal three-fifths so tips reach median line in cloacal region (Figs. 1, 2, 10, 14). Shorter of two subsidiary distal prongs of each spicule originating from mediodorsal surface of main shaft, paralleling it and terminating in rather blunt, but digitate, medioventrally directed tip; remaining subsidiary prong originating from laterodorsal surface of main shaft, paralleling other prongs in most of length, usually curving dorsally away from them to rather sharp but digitate tip (Figs. 11, 12). Gubernaculum brownish, more or less boat-shaped, with very strongly chitinized dorsal keel ending proximally in knob and branching near distal tip to form pair of lateral crura (Fig. 9) reenforcing small dorsolateral triangular alate projections, which merge with main lateroventrally directed wings (Fig. 15). In cloacal region light brownish chitinized structures, representing the telemon, present; telemon grossly appearing in lateral view to be organized into three main sections, one lying along the posteroventral body wall, one along the lateroventral wall of the cloaca, and the remaining one along the laterodorsal wall of the cloaca (Figs. 2, 17), but consisting of a considerable number of more or less distinct, yet interrelated and apparently interconnected elements (Figs. 8, 16).

Female.—In 6 specimens 37.7 to 43.3 mm long by 0.40 to 0.58 mm wide at vulva; esophagus, 1.00 to 1.29 mm long; tail, 0.41 to 0.56 mm long; distance from vulva to posterior extremity 8.2 to 9.6 mm (ratio to body length, 1:4.1 to 1:4.7); eggs 88 to 105μ by 50 to 62μ. Tail digitiform, bent slightly dorsad at tip, without terminal spike or other cuticular or hypodermal modification (Fig. 13).

Hosts.—*Sciurus carolinensis leucotis*; *S. carolinensis*; *S. niger niger*.

Location.—Stomach.

Locality.—Moorefield, Hardy County, W. Va.; Virginia; Newton, Ga.

Specimens.—U.S.N.M. Helm. Coll. no. 36814 (holotype, male); no. 36853 (allotype); no. 36854 (paratypes, 1 male and several females); no. 45329 (removed from lot no. 2934); no. 42772.

Remarks.—The striking and readily observed character of ray chitinization is obviously one of great practical value in identification. The systematic importance, however, that should be attached to it is a question concerning which a consensus is not likely to be reached until specimens with chitinized rays have been more widely discovered and studied. Travassos[5] included *Böhmiella* in the Trichostrongylinae provisionally only and believed that further study of the bursa of the genotype might justify placing the genus in a separate major group. The writer does not regard ray chitinization as a fundamental morphological modification and believes that, by itself, the character should be assigned no more than specific value. It seems probable that this was Gebauer's[6] opinion also, since he did not propose *Böhmiella* simply because of the occurrence of this phenomenon. It is in a combination of characters that *B. perichitinea* appears to differ from other trichostrongylins sufficiently to warrant considering it a representative of a distinct genus.

[5] *Op. cit.* [6] *Op. cit.*

The specimens here described are in many of their general features similar to *B. perichitinea* and are, therefore, regarded as representatives of the same genus. They differ in many respects, however, from the genotype as described by Gebauer and, therefore, are regarded as representing a new species.

It is conceded that certain of the described differences between *B. wilsoni* and *B. perichitinea* are of possible generic value. Notable among them are discrepancies in the number of cephalic papillae and in the nature of the buccal cavity and of the anterior end of the esophagus, and, corollary to the last, in the derivation, position, and orientation of the dorsal onchium and the denticles associated with it; also in this category are the presence in *B. wilsoni* of a circumoral elevation and a rudimentary leaf crown. However, the writer suspects that reexamination of the type specimens of *B. perichitinea* may reveal a closer similarity and relationship to *B. wilsoni* in these respects than now is evident.

In addition to the differences thus far alluded to, *B. wilsoni* is distinguished from *B. perichitinea* by presence of prebursal papillae and a telemon, absence of cervical alae, less marked inequality in the depth of the clefts between the dorsal and lateral lobes of the bursa, lack of dextral curvature and an accessory ventral rodlike process in the dorsal ray, longer spicules of different shape and orientation, larger gubernaculum, larger females with more anteriorly situated vulva, greater number of longitudinal cuticular ridges, shorter dorsal onchium, mediolateral and posteriorlateral rays longer than externolaterals, and lateroventral rays thicker than externodorsals. There also appear to be differences in the extent of the internal chitinized processes in the caudal region, notably, the absence in *B. wilsoni* of a narrow process extending between the spicules and the anterior extremity of the dorsal process, as well as absence of the pair of broom-shaped lateral processes, figured for *B. perichitinea*.

ZOOLOGY.—*Observations on the route of migration of the common liver fluke,* Fasciola hepatica, *in the definitive host.*[1] WENDELL H. KRULL and R. SCOTT JACKSON, U. S. Bureau of Animal Industry.

The essentials of the life history of the common liver fluke, *Fasciola hepatica*, have been known since 1882, when Thomas and Leuckart, independently, showed that the snail *Lymnaea truncatula* served as an intermediate host of this important parasite. In spite of these and subsequent investigations there still remain details concerning the development of the fluke in the intermediate and definitive hosts that have not been fully worked out. Important among these is the route of migration to the liver of the young fluke after its excystment in the digestive tract of the definitive host.

Three possible routes of migration have been postulated, namely, (1) direct migration from the intestine to the bile ducts through the hepatic duct; (2) passive transportation by the portal circulation after penetration of the intestinal mucosa, the young fluke gaining access to the bile ducts by perforation; and (3) penetration of the intestine, active migration in the peritoneal cavity, perforation of the liver capsule, and migration through the liver parenchyma to the bile ducts. The first of these possible routes is the one most generally accepted, although it is the only one entirely unsupported by experimental evidence. On the other hand, Bugge (1935) concluded, on the basis of his examination of numerous infected calves, that the young flukes reached the liver via the portal system. Sinitsin (1914) demonstrated young flukes in the washings from the abdominal cavity of rabbits to which encysted cercariae had been administered and concluded that the flukes must reach the liver through active penetration of the liver capsule; this observation was supported by Shirai (1927). Sinitsin's theory was further supported by Shaw (1932), who injected larval flukes directly into the peritoneal cavities of rabbits, guinea pigs, and lambs and observed that the young flukes penetrated the hepatic

[1] Received November 2, 1942.

capsule; juvenile flukes were later recovered from the liver. While the observations of these investigators demonstrated the ability of the excysted metacercariae to gain access to the liver by penetration of the liver capsule, it was not shown that this route is the normal one or that the young flukes on reaching the liver could gain access to the bile ducts and become mature. Since the flukes are sometimes found in such abnormal locations as the lungs and elsewhere, and may even be acquired prenatally, it would seem reasonable to conclude that migration to the liver via the peritoneal cavity was not the usual one. In order to secure additional information on the course of migration of *F. hepatica* in the definitive host, a number of experiments involving the transfer of larval flukes from one definitive host to another were carried out; the results of these experiments are presented in this paper.

MATERIALS AND METHODS

The larval flukes used in the transfer experiments described herein were obtained by administering to white mice and guinea pigs (first definitive hosts) cysts of *F. hepatica* obtained from laboratory infected snails. After a number of days had elapsed, the definitive hosts were killed, the young flukes recovered either from the peritoneal cavity or the liver tissue, and transferred in saline by means of a pipette directly into the peritoneal cavities of guinea pigs, rabbits and sheep (second definitive hosts). Guinea pigs were found to be unsatisfactory for this purpose, as the flukes failed to reach maturity in them. In making the transfers, a surgical incision was made in the test animal in the region of the flank, in the case of abdominal transfers, and between the ribs, in the thoracic transfers, the operative openings being closed by sutures. The operations were carried out either under local or general anesthesia.

EXPERIMENTAL DATA

1. *Direct transfer of immature flukes to abdominal cavity of rabbits and sheep*

Larval flukes were transferred directly to the abdominal cavities of 20 rabbits and 3 sheep, and the results of these experiments are given in Table 1. The data presented in this table show that young flukes obtained from one definitive host will, when transferred to a second definitive host, reach the liver and become mature in the bile ducts. These data also indicate that the average time for the flukes to reach fertile maturity in rabbits is somewhat less than in sheep, the range being 62 to 99 (average 71) days in rabbits and 79 to 101 (average 86) days in sheep (includes period in first definitive host). Since only three sheep were involved in these experiments it is possible that had a larger number of animals been used the average time required for the flukes to mature might have been slightly less.

The importance of a sufficient flow of bile for the fluke in the bile duct is shown by the data for rabbit 1. These flukes although 88 days old when recovered were still immature, being only 9 and 12 mm long, respectively, when relaxed. They had lodged in the minor, peripheral bile ducts of the lobes of the liver, whereas the flukes which make a normal growth are usually found in the largest ducts.

Usually conspicuous points of entrance of juvenile flukes are discernible on the liver surface. The lesions persist for weeks, and the ability to repair such damage seems to vary considerably with different species. Healing is more rapid and complete in guinea pigs than in sheep and rabbits.

In order to ascertain whether the transfer of immature flukes from one host animal to another affected the rate of maturity, encysted metacercariae were administered *per os* to three rabbits and one sheep. The first rabbit received 11 cysts; eggs appeared in the feces 66 days later and 1 fluke was recovered at necropsy. The second rabbit received 17 cysts; eggs appeared in the feces in 69 days, and six flukes were recovered at necropsy. The third rabbit received 40 cysts; eggs appeared in the feces in 81 days, and six flukes were recovered at necropsy. The sheep (no. 12039) received 130 cysts; eggs appeared in the feces in 75 days, and 21 mature flukes were recovered from the bile ducts when the animal was necropsied 30 days later.

The results of these experiments parallel

those obtained by direct transfer of the immature flukes and show that the time required for reaching maturity is not materially affected by the manipulations necessary during the transfers.

2. Direct transfer of immature flukes to the pleural cavity of rabbits

Since the liver fluke has been reported on a number of occasions from abnormal locations, even under circumstances indicating prenatal infection,[2] the prevailing opinion is that in order for the flukes to reach unusual locations they must be transported by the circulation. In order to secure information on this point, limited experiments were conducted as follows:

Four 30-day-old larval flukes obtained from the liver of a mouse were transferred to the thoracic cavity of a fully grown rabbit. This animal was examined two months later and the thoracic organs appeared normal; examination of the liver, however, revealed a single specimen of *F. hepatica*, 20 mm long by 7 mm wide, in one of the bile ducts. In a second rabbit, about one-fourth grown, two 22-day-old flukes were transferred to the thoracic cavity; this animal was examined a month later and a single fluke 25 mm long by 6.5 mm wide that had just reached maturity was recovered from the liver. A typical entrance point was observed in the liver capsule indicating that the fluke had reached the liver by migration.

A third rabbit, almost fully grown, received by direct transfer into the thoracic cavity four 30-day-old flukes. A week later this animal developed paralysis of the hind quarters and died a week after the symptoms appeared. On examination one lung was found to be hemorrhagic, a portion of

[2] One case of liver fluke infection was observed in the vicinity of Logan, Utah, in a 6-weeks-old calf; the flukes were all mature.

TABLE 1.—RESULTS OF INFECTIONS OF FASCIOLA HEPATICA IN RABBITS AND SHEEP PRODUCED BY THE DIRECT TRANSFER OF IMMATURE FLUKES TO THE ABDOMINAL CAVITY

Animal designation	Source of flukes	Length of flukes	Age of flukes at time of transfer	Flukes transferred	Appearance of eggs in feces[5]	Age of flukes at time of oviproduction[6]	Days in final host—rabbit or sheep	Flukes recovered
		Mm	*Days*	*Number*	*Days*	*Days*	*Days*	*Number*
Rabbit 1	Mouse	—	7	2	0	—	81	2[1]
Rabbit 2	do	—	8	3	66	74	76	1
Rabbit 3	Mice	1.0–1.5	8	2	66	74	73	2
Rabbit 4	Mouse	1.0–1.5	9	2	61	70	66	1
Rabbit 5	do	3.0±	16	3	52	68	55	3
Rabbit 6	do	3.0±	16	11	50	66	63	11
Rabbit 7	do	—	16	5	54	70	66	4
Rabbit 8	do	—	9	2	0	—	78	0
Rabbit 9	Mice	2.0–4.0	20	8	45	65	58	8
Rabbit 10	Mouse	1.0–1.5	8	6	0	—	35	6[1]
Rabbit 11	do	6.5–8.0	28	3	34	62	36	2
Rabbit 12	do	6.5–8.0	28	3	44	72	62	2
Rabbit 13	do	6.5–8.0	28	1	44	72	64	1
Rabbit 14	do	6.5–8.0	28	3	34	62	62	1
Rabbit 15	do	6.5–8.0	27	4	—	—	15	3[1]
Rabbit 16	do	6.5–8.0	30	4	46	76	88	3
Rabbit 17	Mice	—	30	4	—	—	19	2[1]
Rabbit 18	Guinea pig	8.0	29	1	—	—	77	0
Rabbit 19	do	6.0	31	2	—	—	99	2
Rabbit 20	do	6.0	31	3	68	99	68	2
Sheep 12023	Mice	less than 1.0	5	15	74	79	697	—[3]
Sheep 12083	do	1.0–2.0	11	41	90	101	100	10[3]
Sheep 12026	do	2.0–4.0	20	45[4]	59	79	77	17

[1] Immature.
[2] Animal not destroyed, fluke eggs still numerous.
[3] Some flukes immature.
[4] Transfer made through cannula; some young flukes may have been lost.
[5] Days in rabbit or sheep.
[6] Total days in mouse or guinea pig and rabbit or sheep.

the pericardium was thickened and congested, and the thymus was hemorrhagic with adhesions between it and the thoracic wall. No flukes were recovered directly from the organs, but one specimen that showed considerable growth was recovered from the water in which the thoracic organs were manipulated. It is assumed that the paralysis occurring in this case was the result of the fluke infection as no cases of this sort have occurred during several years in the rabbit colony from which this animal was obtained.

In the fourth experiment three 27-day-old flukes were transferred to the thoracic cavity of a mature rabbit. This animal died 22 days after the transfer. On necropsy the parietal pleura in the region of the operative opening was roughened, and there were small hemorrhages in the intercostal muscles. Flecks and strands of fine connective tissue were present on the surface of the lung and areas of scar tissue were observed in the lung tissue which were probably the result of injuries caused by the migrating flukes. The pleural sac was ruptured medially posterior and dorsal to the heart and a portion of the lung had passed through this opening and had become strangulated. The strangulated portion of the lung was consolidated and was showing evidence of necrosis; adhesions and connective tissue deposits were present in this region. No flukes were recovered from this animal.

SUMMARY AND CONCLUSIONS

These experimental data show that, if juvenile flukes reach the peritoneal cavity of rabbits and sheep, they migrate to the liver, penetrate the capsule and parenchyma, enter the bile ducts, and mature. Furthermore, it is shown that entrance through the bile duct is precluded as necessary in the infection of rabbits and sheep; however, it is not eliminated as a possible infection route. In view of the experiments recorded in this paper, particularly those concerning the transfer of flukes to the thoracic cavity, and because of the large size of some of the flukes transferred, the circulatory system as a transfer route also is precluded as being necessary; however, a source of blood seems to be essential for survival; the juvenile flukes are able to secure blood because of their ability to penetrate tissues. Since 78 percent (56 flukes) of the 72 juvenile flukes used in the transfer experiments with rabbits were recovered in necropsies, there is reason to believe that infection via the peritoneal cavity is the principal, if not the sole route, of infection. The limited experiments involving the transfer of juvenile flukes to the thoracic cavity indicate that obscure symptoms of disease, or death, may be traced to liver flukes, even though the flukes themselves may not always be recoverable.

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ZOOLOGY.—*Pycnogonida of the Bartlett collections.*[1] JOEL W. HEDGPETH. (Communicated by WALDO L. SCHMITT.)

Most of the pycnogonids collected by Capt. Robert A. Bartlett in Greenland and Arctic America up to the year 1935 were sent to Dr. Louis Giltay, formerly of the Royal Museum of Natural History, Brussels, Belgium, who prepared a short manuscript on them. Unfortunately Dr. Giltay died before the manuscript was ready for the printer.[2] At the request of Dr. Waldo L. Schmitt, I have prepared this paper on the pycnogonids taken by Captain Bartlett in the Arctic and have included the identifications made by Dr. Giltay, which are designated by an asterisk.

Although the collections made by Captain Bartlett from the coasts of Greenland add no new species to the known fauna of that region, those from Fox Basin represent a hitherto unreported region for these animals. The specimens from Fox Basin comprise the most extensive collection of pycnogonids from the American Arctic that has yet been made. Heretofore, our knowledge of this fauna has been supplied principally by Cole's list (1921) of three species from Dolphin and Union Strait, a single record of *Nymphon serratum* from James Bay (Giltay, 1942), and the earlier records by Rodger (1893) from the coast of Labrador.

Of the 14 species represented in the Bartlett collections 9 are from Fox Basin. These are all well-known Arctic species whose previously established distribution is summarized in Stephensen's (1933) excellent paper on Greenland pycnogonids. American Arctic pycnogonids are still poorly represented in our collections, however, and it is certain that future collecting will add many species to our lists.

I have not seen the material identified by Dr. Giltay. As his manuscript consisted only of identifications, I am responsible for the synonymies, remarks, and arrangements of this paper. All the specimens, except where otherwise noted, were procured by Captain Bartlett on personally sponsored expeditions. The localities from which pycnogonids were secured are listed in geographic sequence from north to south, beginning with Fox Basin (Fig. 1.) The collections, with the exception of two lots taken by the Hudson Bay Fisheries Expedition of 1930 on a steam trawler, the S. S. *Loubyrne*, are in the United States National Museum.

[1] Received December 28, 1942.

[2] Dr. Louis Giltay died on July 25, 1937. A biographical notice with bibliography was published by V. van Straelen in Bull. Mus. Roy. Hist Nat. Belgique 14 (23). (1938).

Family NYMPHONIDAE Wilson, 1878

Genus **Boreonymphon** G. O. Sars, 1891

Boreonymphon robustum (Bell)

Boreonymphon robustum Stephensen, 1933, pp. 4–5, fig. 1 (map); p. 38, fig. 11.

Localities.—Walrus grounds, Murchison Sound, NW. Greenland, app. 77°45′N., station 124, Aug. 7, 1938, 1 large ♀, encrusted with sponges, hydroids, and foraminifers.

King Francis Josef Fjord, NE. Greenland, No. 6A, Aug. 4, 1936, 1 specimen.

Distribution.—A widely distributed Arctic species, perhaps circumpolar but not yet known from between latitudes 120° W. and 160° E. It is often taken in considerable numbers. Stephensen (p. 38) suggests that this species may live on *Umbellula encrinus* and other corals.

Genus **Nymphon** J. C. Fabricius, 1794

Nymphon hirtipes Bell

Nymphon hirtipes Wilson, 1878, pp. 22–23, pl. 5, figs. 2–3; pl. 6, fig. 2a–k.

Nymphon hirtum Wilson, 1880, pp. 495–497, pl. 7, figs. 38–41.

Chaetonymphon hirtipes Sars, 1891, pp. 103–107, pl. 11, fig. 2a–k.

Chaetonymphon hirtipes Cole, 1921, p. 4.

Chaetonymphon hirtipes Stephensen, 1933, pp. 8–9, figs. 2, 10 (maps).

Localities.—*Entrance to Fury and Hecla Straits, Sept. 3, 1933, 30 fathoms, 3 specimens (Norcross-Bartlett Expedition).

*East end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 50′ W., station 7, Aug. 3, 1935, 140–210 fathoms, bottom sample, gravel, 39 specimens (incl. ovig. ♂♂).

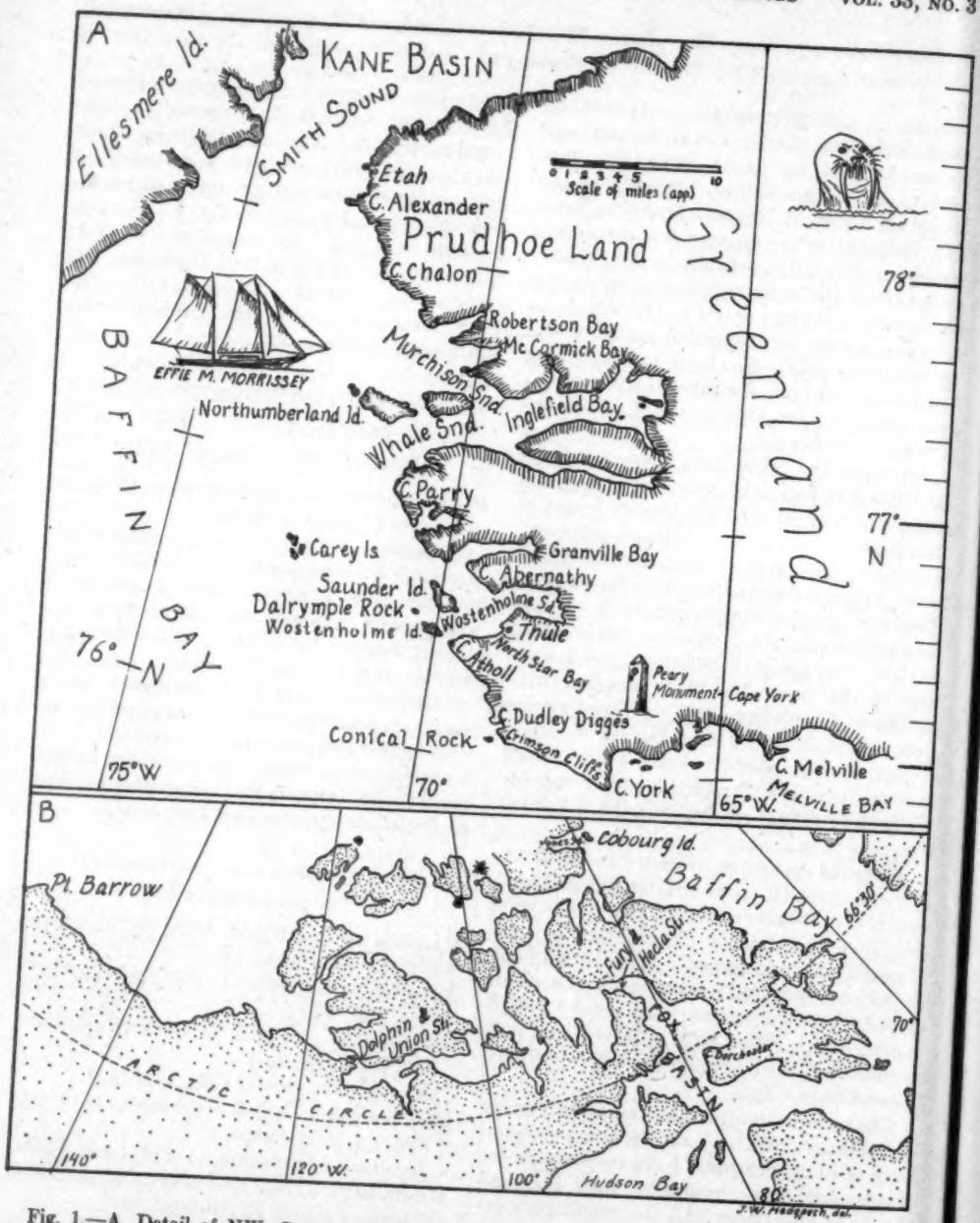

Fig. 1.—A, Detail of NW. Greenland, showing localities represented in the Bartlett collections; B, The American Arctic (only those localities from which pycnogonids have been collected are indicated). *Type locality of *Boreonymphon robustum* (approximate; probably also of *Nymphon hirtipes*). ●Type locality of *Colossendeis proboscidea* (approximate).

*Thule, North Star Bay, NW. Greenland, 76° 32′ N., 68° 45′ W., Aug. 27, 1932, 12 fathoms, 1 specimen (Peary Memorial Expedition).

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45′ N., station 124, Aug. 7, 1938, otter trawl, 5 specimens.

Murchison Sound, NW. Greenland, app. 77° 43′ N., station 134, Aug. 7, 1938, otter trawl, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 38′ N., station 146, Aug. 8, 1938, otter trawl, 5 specimens.

Along west side of Wolstenholme Island, station 43, July 23, 1940, 12 fathoms, 1 specimen.

Between north shore of Parker Snow Bay and Conical Rock, NW. Greenland, station 25, July 22, 1940, 25–45 fathoms, +7 specimens.

Off Conical Rock, NW. Greenland, 76° 3′ N., 67° 30′ W., station 76, July 29, 1938, dredged, 1 ♀.

One mile northwest of Conical Rock, NW. Greenland, station 37, July 22, 1940, 25–60 fathoms, 7 specimens.

*Angmagsalik, SE. Greenland, Aug. 30, 1930, dredge, 1 specimen.

Off SE. Greenland, 61° N., 62° 30′ W., station 166, Aug. 24, 1939, otter trawl, mud and pebbles, 5 specimens.

Prince Christian Sound, SE. Greenland, 61° 10′ N., station 175, Aug. 25, 1939, 80–90 fathoms, otter trawl, 2 specimens.

Off Cape Farewell, S. Greenland, station 207, Aug. 25, 1939, 40–100 fathoms, otter trawl, 1 specimen.

*NE. Greenland, 74° 21′ N., 16° 30′ W., July 29, 1931, 120 fathoms, 1 specimen (Norcross-Bartlett Expedition).

*NE. Greenland, 74° 04′ N., 17° 58′ W., July 30, 1931, 120 fathoms, 4 specimens (Norcross-Bartlett Expedition).

Distribution.—An Arctic and boreal-Arctic species, widely distributed in the northern Atlantic and from Kara Sea to NW. Greenland in the Arctic. Cole's record from Dolphin and Union Strait is the westernmost record. It is known also from eastern United States, Halifax to Massachusetts Bay (Wilson). Apparently it is not circumpolar. Other hitherto unpublished records are Baldwin-Ziegler Polar Expedition, June, 1901, Aberdare Channel, east of Alger Island, Franz Josef Land, 7 specimens; and station 19, S. S. *Loubyrne*, Hudson Bay Fisheries Expedition, 61° 11′ N., 90° W., August 15, 1930, 75 fathoms, mud and stones, 1 specimen.

Nymphon brevitarse Kröyer

Nymphon brevitarse Stephensen, 1933, pp. 10–11.

Localities.—*SE. corner of Fox Basin, 66° 46′ N., 79° 15′ W., Aug. 13, 1927, 34–37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

South shore of Southampton Island, Hudson Bay, 63° 10′ N., 85° 25′ W., station 3, Aug. 3, 1933, from floating seaweed, 1 specimen (Norcross-Bartlett Expedition).

Between Cape Alexander and Cape Chalon, NW. Greenland, station 29, Aug. 2, 1937, 25–40 fathoms, rocky bottom, 3 specimens.

Walrus grounds, Murchison Sound, NW. Greenland, 77° 45′ N., station 127, Aug. 7, 1938, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 38′ N., station 146, Aug. 8, 1938, 1 specimen.

Distribution.—An Arctic species, from Spitsbergen to NW. Greenland and Fox Basin. From shallow water, not more than 50 fathoms. Rodger (1893) reports the species from the Straits of Belle Isle. One specimen was collected by the Baldwin-Ziegler Expedition in Aberdare Channel, Franz Josef Land.

Nymphon grossipes (O. Fabricius?) Kröyer

Nymphon grossipes Stephensen, 1933, pp. 11–12.

Localities.—*Fox Basin, 66° 30′ N., 80° W., Aug. 10, 1927, 14 specimens (Putnam Baffin Land Expedition).

Fox Basin, 66° 30′ N., 80° W., Aug. 10, 1927, 4 specimens. Identified by Giltay as *N. mixtum*, a synonym of *N. grossipes*. (Putnam Baffin Land Expedition.)

Southeast corner of Fox Basin, 66° 46′ N., 79° 15′ W., Aug. 13, 1927, 34–37 fathoms, dredge, 1 specimen. Identified by Giltay as *N. mixtum*. (Putnam Baffin Land Expedition.)

*Southeast corner of Fox Basin, 66° 46′ N., 79° 15′ W., Aug. 13, 1927, 37 fathoms, dredge, 15 specimens (incl. ovig. ♂♂) (Putnam Baffin Land Expedition).

*Center of Fox Basin, Aug. 24–25, 1927, 25 fathoms, 10 specimens (Putnam Baffin Land Expedition).

*Fox Basin, Aug. 26, 1927, 25–31 fathoms, 1 specimen (Putnam Baffin Land Expedition).

East end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 40′ W., Aug. 3, 1935, 140–210 fathoms, gravel, 1 specimen. Identified by Giltay as *N. mixtum*.

*South end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 58′ W., Aug. 4, 1935, 48–80 fathoms, rocky, 1 specimen.

*South end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 59′ W., Aug. 4, 1935, 68–120 fathoms, rocky, 1 specimen.

Between Cape Alexander and Cape Chalon, NW. Greenland, station 27, Aug. 2, 1937, 25–40 fathoms, rocky, 3 specimens.

*Walrus feeding grounds, 5 miles north of Cape Chalon, Prudhoe Land, NW. Greenland, July 27, 1932, 1 specimen.

Murchison Sound, NW. Greenland, app. 77° 45′ N., station 126, Aug. 7, 1938, otter trawl, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 38′ N., station 146, Aug. 8, 1938, 1 specimen.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45′ N., station 124, Aug. 7, 1938, otter trawl, 3 specimens.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45′ N., station 127, Aug. 7, 1938, otter trawl, 1 specimen.

Northumberland Island, NW. Greenland, station 49, Aug. 7, 1937, dredge, 1 specimen.

*Northumberland Island, NW. Greenland, Aug. 1926, 1 specimen.

Off Dalrymple Rock, Wostenholme Sound, July 22, 1926, 2 specimens (1 ovig. ♂).

Off northwest shore of Wostenholme Island, NW. Greenland, station 57, July 23, 1940, 13–25 fathoms, 1 specimen.

Off Wostenholme Island, NW. Greenland, station 44, July 23, 1940, 13–17 fathoms, 1 specimen.

Off Wostenholme Island, NW. Greenland, station 46, July 23, 1940, 13–17 fathoms, 1 specimen.

One mile northwest of Conical Rock, NW. Greenland, station 38, July 23, 1940, 25–60 fathoms, dredge, 1 specimen.

Kerkoliak, Salve Island, Melville Bay, NW. Greenland, Aug. 28, 1932, dredge, 1 specimen. Identified by Giltay as *N. mixtum*.

Off Cape Farewell, S. Greenland, station 207, Aug. 25, 1939, 40–100 fathoms, otter trawl, 2 specimens.

Off Cape Farewell, S. Greenland, station 196, Aug. 25, 1939, 60–70 fathoms, 1 specimen.

Off Cape Farewell, S. Greenland, station 218, Aug. 25, 1939, 60–70 fathoms, 3 specimens.

*Clavering Fjord, NE. Greenland, Aug. 2, 1930, 1 specimen.

Nymphon mixtum Krøyer and *N. glaciale* Sars can not be separated from *N. grossipes*, as Stephensen (p. 12) has shown, and I concur with his synonymy.

Distribution.—A widely distributed and very variable species, found on the North American coast as far south as Long Island Sound on the east and Puget Sound on the west. It is circumpolar, Arctic, and boreal-Arctic; littoral to +500 fathoms.

Nymphon longitarse Krøyer

Nymphon longitarse Norman, 1908, pp. 212–213.

Nymphon longitarse Cole, 1921, p. 4.

Nymphon longitarse Stephensen, 1933, pp. 13–14, fig. 3 (map).

Nymphon longitarse Losina-Losinsky, 1933, pp. 67–68.

Nymphon longitarsi Hilton, 1942a, pp. 3–4.

Locality.—Frobisher Bay, Baffin Land, about 60 fathoms, 1 specimen.

Distribution.—A boreal-Arctic species, widely distributed from the coasts of Norway and Britain in Europe to Cape Cod on the American coast (rarely south to about lat. 40° N., but not to Cape Hatteras as suggested by Norman in his distribution table, p. 199). It is also circumpolar, having been recorded from Point Barrow (Cole) and from eastern Siberian waters (Losina-Losinsky). Hilton lists its from Kodiak and "Alaskan waters." It is a littoral to sublittoral species.

Nymphon sluiteri Hoek

Nymphon sluiteri Cole, 1921, pp. 3–4.

Nymphon sluiteri Stephensen, 1933, p. 14, fig. 4 (map).

Localities.—*East end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 55′ W., Aug. 3, 1935, 150–280 fathoms, muddy, 1 specimen.

Between Cape Alexander and Cape Chalon, NW. Greenland, station 29, Aug. 2, 1937, 25–40 fathoms, rocky, 1 specimen (juv.).

Distribution.—A circumpolar Arctic species, found in shallow water in the high Arctic and in deeper water in the southern part of its range (Faroes and Jan Mayen). Several specimens were collected by the Baldwin-Ziegler Polar Expedition in Aberdare Channel, Franz Josef Land, June, 1901.

Nymphon sluiteri has also been collected in the Gulf of St. Lawrence, where two specimens were dredged by Dr. Georges Préfontaine at Trois Pistoles, Quebec, in 200 meters, July, 1932 (U.S.N.M. 66540). This appears to be the southernmost record for this species. It does not appear to reach New England waters as do other Arctic species like *Nymphon hirtipes* and *Pseudopallene circularis*. Possibly its occurrence in the Gulf of St. Lawrence is rare or sporadic.

Nymphon elegans Hansen

Nymphon elegans Stephensen, 1933, p. 17.

Localities.—Fox Basin, 45 miles east of Cape Dorchester, Aug. 8, 1927, 1 specimen (Putnam Baffin Land Expedition).

*Southeast corner Fox Basin, 66° 45′ N., 79° 15′ W., Aug. 13, 1927, 34–37 fathoms, dredge, 5 specimens (Putnam Baffin Land Expedition).

*Center of Fox Basin, Aug. 24–25, 1927, 25 fathoms, 3 specimens (Putnam Baffin Land Expedition).

*Fox Basin, Aug. 26, 1927, 25–31 fathoms, dredge, 2 specimens (Putnam Baffin Land Expedition).

*Fox Basin, 66° 30′ N., 80° W., Aug. 10, 1927, 6 specimens (Putnam Baffin Land Expedition).

*Fox Basin, 66° 43′ N., 80° 07′ W., Aug. 1927, dredge, 2 specimens (Putnam Baffin Land Expedition).

*East end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 40′ W., Aug. 3, 1935, 140–210 fathoms, gravel, 10 specimens.

Walrus grounds, Murchison Sound, NW. Greenland, app. 77° 45′ N., station 124, Aug. 7, 1938, otter trawl, 1 specimen.

Distribution.—An Arctic species, from the Kara Sea to W. Greenland, and Fox Basin. Usually taken in somewhat deeper water, i.e., about 100–300 fathoms.

Nymphon serratum G. O. Sars

Nymphon serratum Stephensen, 1933, pp. 18–19.

Nymphon serratum Giltay, 1942, p. 459.

Localities.—*Southeast corner Fox Basin, 66° 46′ N., 79° 15′ W., Aug. 13, 1927, 34–37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

Between Cape Alexander and Cape Chalon, NW. Greenland, station 29, Aug. 2, 1937, 25–40 fathoms, rocky, 1 specimen.

Walrus grounds, Murchison Sound, app. 77° 45′ N., station 124, Aug. 7, 1938, otter trawl, 1 specimen.

Whale Sound, NW. Greenland, Jar H, July 28, 1937, rocky bottom, 1 specimen.

One mile northwest of Conical Rock, station 37, July 22, 1940, 25–60 fathoms, 1 specimen.

West Greenland, 70° 20′ N., 56° W., June 12, 1884, Ensign C. S. McLain, U.S.N., coll., 1 specimen.

Distribution.—An Arctic, sublittoral species from Kara Sea to W. Greenland and Hudson Bay (Giltay). Another specimen from Hudson Bay was taken by the S.S. *Loubyrne* (Hudson Bay Fisheries Expedition), station 31, Aug. 22, 1930, 41 fathoms, gravel. It is occasionally taken in the Atlantic just south of Wyville-Thomson Ridge (Stephensen).

Nymphon megalops G. O. Sars Fig. 2

Nymphon megalops Stephensen, 1933, p. 19.

Localities.—*Fox Basin, 66° 43′ N., 80° 07′ W., Aug., 1927, dredge, 2 specimens. Identified by Giltay as *N. sarsi*. (Putnam Baffin Land Expedition.)

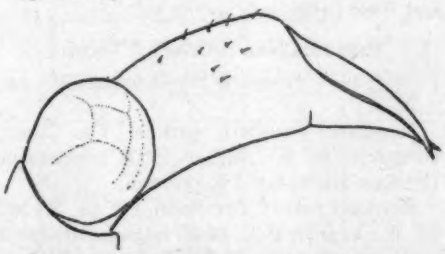

Fig. 2.—Right chela (reversed) of *Nymphon megalops*, showing rounded outgrowth.

Between Cape Alexander and Cape Chalon, NW. Greenland, Jar W, Aug. 2, 1937, 1 specimen.

Walrus feeding ground, Murchison Sound, NW. Greenland, app. 77° 42′ N., station 135, Aug. 7, 1938, otter trawl, 2 specimens.

There seems to be no significant difference between this species and Meinert's (1899, pp.

48–49) *Nymphon sarsi*. The right chela of the specimen (♂) from between Cape Alexander and Cape Chalon has a large rounded deformity (Fig. 2).

Distribution.—An Arctic species, from western Norway to Fox Basin; south to about 61° 30′ N., in the Faroe Channel. Usually from deep water.

Family PALLENIDAE Wilson, 1878

Genus **Pseudopallene** Wilson, 1878

For reasons to be discussed in detail in another paper, the use of *Phoxichilus* Latreille (hitherto used for *Endeis* Philippi by practically all authors) for *Pseudopallene* Wilson as recommended by Norman (1908, pp. 231–233) and Marcus (1940, p. 128) is rejected as an unnecessary confusion. It is much simpler to abandon *Phoxichilus* entirely.

Pseudopallene spinipes (O. Fabricius)

Pseudopallene spinipes Stephensen, 1933, p. 21.

Localities.—East end of Cobourg Island, Baffin Bay, 75° 40′ N., 78° 40′ W., station 8b, Aug. 3, 1935, 140–200 fathoms, gravel, 1 specimen.

Off Cape Farewell, S. Greenland, station 197, Aug. 25, 1939, 60–70 fathoms, 1 specimen.

Off Cape Farewell, S. Greenland, station 208, Aug. 25, 1939, 60–70 fathoms, washed from seaweed, 1 specimen.

Distribution.—An Arctic species, from western Norway, Kara Sea, Franz Josef Land, and West Greenland; sublittoral.

Pseudopallene circularis (Goodsir)

Pseudopallene circularis Stephensen, 1933, pp. 20–21.

Localities.—Southern part of Fox Basin, 66° 30′ N., 80° W., Aug. 10, 1927, 2 specimens (Putnam Baffin Land Expedition).

Southern part of Fox Basin, 66° 43′ N., 80° 07′ W., Aug. 12, 1927, 32–37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

*Center of Fox Basin, Aug. 24–25, 1927, 25 fathoms, dredge, 3 specimens (Putnam Baffin Land Expedition).

*Fox Basin, Aug. 25, 1927, 25–31 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

*Southern part of Fox Basin, 66° 43′ N. 80° 07′ W., Aug., 1927, dredge, 1 specimen (Putnam Baffin Land Expedition).

Walrus feeding grounds, Murchison Sound, NW. Greenland, app. 77° 42′ N., station 135, Aug. 7, 1938, otter trawl, 1 specimen.

Walrus feeding grounds, Murchison Sound, NW. Greenland, app. 77° 45′ N., station 127, Aug. 7, 1938, 1 specimen.

Just back of Cape Farewell, S. Greenland station 210, Aug. 25, 1939, 70 fathoms, 1 specimen.

Distribution.—A boreal-Arctic species, from Okhotsk Sea to West Greenland, south to the Firth of Forth and southern Norway on the coast of Europe and to Cape Cod in American waters; littoral to shallow water. It is much smaller in the southern parts of its range.

Family AMMOTHEIDAE Dohrn, 1881

Genus **Eurycyde** Schiödte, 1857

Eurycyde hispida (Kröyer)

Eurycyde hispida Stephensen, 1933, p. 27.

Localities.—*Southern part of Fox Basin, 66° 30′ N., 80° W., Aug. 10, 1927, 2 specimens (Putnam Baffin Land Expedition).

*Southeast corner Fox Basin, 66° 46′ N., 79° 15′ W., Aug. 12, 1927, 34–37 fathoms, 7 specimens (Putnam Baffin Land Expedition).

*Center of Fox Basin, Aug. 24, 1927, 25 fathoms, 13 specimens (Putnam Baffin Land Expedition).

*Fox Basin, 67° 45′ N., 79° 09′ W., Aug. 24, 1927, 38 fathoms, 3 specimens (2 ovig. ♂♂) (Putnam Baffin Land Expedition).

*Fox Basin, Aug. 26, 1927, 25–31 fathoms, 2 specimens (Putnam Baffin Land Expedition).

*Fox Basin, 67° 43′ N., 80° 07′ W., Aug., 1927, dredge, 3 specimens (Putnam Baffin Land Expedition).

Walrus feeding grounds, Murchison Sound, NW. Greenland, app. 77° 42′ N., station 136, Aug. 7, 1938, 1 specimen.

Distribution.—An Arctic, littoral to sublittoral species, ranging from the Kara Sea to Baffin Land and Greenland (Stephensen) and as far south as Kristiansund on the Norwegian coast. It is unknown from Iceland.

Family COLOSSENDEIDAE Hoek, 1881

Genus **Colossendeis** Jarzynsky, 1870

Colossendeis proboscidea (Sabine)

Colossendeis proboscidea Stephensen, 1933, p. 28, fig. 6 (map).

Locality.—*Southeast corner Fox Basin, 66°

46′ N., 79° 15′ W., Aug. 13, 1927, 34–37 fathoms, dredge, 1 specimen (Putnam Baffin Land Expedition).

Distribution.—Possibly a circumpolar Arctic Basin species, from shallow water to about 500 fathoms. Unknown outside of Arctic waters (Stephensen).

ZOOGEOGRAPHICAL REMARKS

The status of our present knowledge of the distribution of pycnogonids in the American Arctic is summarized in Table 1. There are undoubtedly many more species in this sector; Stephensen (1933, pp. 32–33) lists at least 30 species from the waters west of Greenland alone, and the 14 species in the table are but half that number. While this is a considerable addition to the 6 species mentioned by Cole (1921, p. 5) for the region, our records from the north of Canada are far from extensive, and the localities represented are remarkably few. It is worthy of note that the American Arctic is the type locality for two of the character species of the Arctic Basin, *Boreonymphon robustum* and *Colossendeis proboscidea* (Fig. 1, B).

In recent preliminary papers, Hilton (1942a, b) has listed some pycnogonids from the Bering Sea and Alaskan waters that may establish the circumpolar distribution of certain well-known Arctic species when more adequately identified. Although it is impossible, from the preliminary diagnoses, to recognize or identify any of the species mentioned in these papers, the occurrence of *Nymphon gracile* Leach in Alaskan waters (Hilton, 1942a, p. 7) is doubtful. This might be *Nymphon brevitarse; N. gracile* (sometimes confused with *N. rubrum* Hodge or *N. brevirostre* Hodge, e.g., *Nymphon gracile* Sars, 1891, *non* Leach—see also Stephensen, 1935, pp. 9–10) is a European species, from Denmark to the Mediterranean. "*Nymphon gracillipes*" (*stromi?*) is also listed (*ibid.*, p. 4), from the Bering Sea at *Albatross* station 3540 (Aug. 9, 1893, 56° 34′ 00″ N., 167° 19′ 00″ W., 57 fathoms). Two new species of *Pseudopallene, P. setosa* and *P. spinosa*, are alluded to (Hilton, 1942b, p. 39), one or both of which might be the variable *Pseudopallene circularis*.

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TABLE 1.—DISTRIBUTION OF PYCNOGONIDS IN THE AMERICAN ARCTIC (EXCLUSIVE OF WEST GREENLAND)

Species	Labrador	Baffin Land (and Cobourg Island)	Hudson Bay	Fox Basin	Dolphin and Union Strait	Point Barrow	Other records[1]
Boreonymphon robustum		×					76°52′ N., 97° W.
Nymphon hirtipes	×	×	×	×	×		
brevitarse	×		×	×			
grossipes	×	×		×		×	
longitarse		×			×	×	
sluiteri	×	×			×		
elegans	×	×		×			
serratum			×	×			
megalops				×			
macronyx		×					
Pseudopallene spinipes		×					
circularis	×	×		×			
Eurycyde hispida		×		×			
Colossendeis proboscidea				×			75° N., 100° W.

[1] Both of these records are type localities. *Nymphon hirtipes* probably has the same type locality as *Boreonymphon robustum*, but I have not had access to the original paper to verify this. Both species were described by T. Bell in *The Last of the Arctic voyages*, by Edward Belcher, vol. 2, pp. 400–411, 1855.

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ICHTHYOLOGY.—*Notes on the affinity, anatomy, and development of* Elops saurus *Linnaeus.*[1]

SAMUEL F. HILDEBRAND, Fish and Wildlife Service.

C. Tate Regan in "A Revision of the Fishes of the Genus Elops" (Ann. Mag. Nat. Hist. (ser. 8) **3**: 37–40. 1909), among other revisions, recognized the inhabitants of this genus on the Pacific coast of America as distinct from *E. saurus* of the Atlantic coast, with which they had been considered identical. He named the Pacific coast species *E. affinis.* In the same paper, Regan recognized the form with small scales (the one with large scales being *E. lacerta* Cuvier and Valenciennes) of the west coast of Africa as also distinct from *E. saurus*, giving it the name *E. senegalensis.* Recently I have studied many specimens of *E. saurus*, including growth series, ranging from leptocephali with virtually undeveloped fins, except for the forked caudal, to large adults. The specimens were collected in many localities on the Atlantic coast of America from Cape Cod to Recife, Brazil, and the West Indian Islands. I have had for comparison several leptocephali and a moderately large series of adults from several localities on the Pacific coast of America from Guaymas, Mexico, to Payta, Peru; also three adults from Elmina, Ashantee, Africa. The validity of the species mentioned, recognized as new by Regan, originally apparently described from few specimens, has been confirmed by this study.

Elops affinis seems to differ from *E. saurus* only in the greater number of gill rakers, wherein *E. senegalensis* agrees with *E. saurus*, as shown by Table 1. However, the scales in a lateral series are fewer in *E. senegalensis* than in *E. saurus*, as indicated in Table 2. *E. senegalensis* differs from *E. saurus* and *E. affinis* also in having fewer vertebrae. Ten specimens of *E. saurus* have, respectively, 73, 74, 75, 75, 75, 77, 78, 79, 80, and 80 vertebrae in the main axis. Nine leptocephali of the same species have, respectively, 77, 78, 78, 78, 79, 80, 82, 82, and 82 myomeres (enumerations somewhat uncertain because of indistinctness of myomeres posteriorly). The only adult *E. affinis* examined has 77 vertebrae, and six leptocephali have, respectively, 76, 77, 79, 80, and 81 myomeres. The single adult *E. senegalensis* examined has 67 vertebrae. These enumerations are in agreement with those given in Dr. Regan's revision.

So far as I know, the validity of *Elops affinis* has not been questioned. On the other hand, it was accepted by Meek and Hildebrand (Publ. Field Mus. Nat. Hist., zool. ser., **15** (1): 176. 1923), who compared specimens from the opposite coasts of Panama.

The situation with respect to *Elops senegalensis* is somewhat different, as it has been synonymized with *E. saurus*, at least, by Fowler (Bull. Amer. Mus. Nat. Hist. **70** (1): 155. 1936), though accepted by Boulenger (Cat. Fresh-water Fish. Africa **4**: 152. 1916). Although only three specimens from Africa have been available to me for examination, it is evident from the many specimens from the Atlantic coast of America studied that the range in the number of scales in the lateral series in American speci-

[1] Received November 9, 1942.

mens does not include the African material examined (see Table 2), nor that reported upon by Regan, who gave a range of 94 to 98 scales in the lateral series. The specimen of *E. senegalensis* examined for vertebrae by me, as already stated, has 67 segments in the main axis, which is essentially in agreement with Regan, who gave 68 or 69. This range, 67 to 69, in the number of vertebrae in the African specimens, then is fully distinct from the range in 10 American specimens, which is 73 to 80. Although no other differences were found, there can be no doubt on the basis of those set forth that the African specimens are distinct from the American ones. Therefore, *E. senegalensis* stands as a valid species.

It may be noted, incidentally, that the specimens from Payta, Peru (U.S.N.M. 88707), gives a slight extension of the known range of *Elops affinis*, which previously apparently has been recorded only from as far south as "Ecuador." The range northward, given as "California" by Meek and Hildebrand (Publ. Field Mus. Nat. Hist., zool. ser., 15: 177. 1923), apparently should have been Lower California. The northernmost locality from which I have seen specimens is Guaymas, Mexico.

The air bladder in *Elops saurus*, which has a very thin transparent wall, occupies the full length of the abdominal cavity. Ventrally it adheres to the alimentary canal and dorsally to the body wall. Contrary to *Tarpon atlanticus*, which has much cellular tissue within the air bladder (see Babcock, *The tarpon*, ed. 4: 50. 1936; and Hildebrand, Sci. Monthly 44: 246, footnote. 1937), *E. saurus* has none whatsoever. The air bladder of *E. saurus* agrees essentially with that of *Albula vulpes*, except that in the latter the wall is somewhat thicker, and within the bladder, at about midlength, are two small kidney-shaped bodies of cellular tissue.

The alimentary canal in *Elops saurus*, except for the stomach, which consists principally of a large blind sac, is a straight tube (see Fig. 1). The blind sac projects forward to the throat. Throughout its length it lies ventrally of the main canal and parallel with it. A lobe of the liver, which occupies the space between this projection and the heart, forms a "hood" over its blind end. Another lobe of the liver shields its left side, while its right and ventral sides are covered by a "comb" of caeca bound firmly together with connective tissue. In the length of the alimentary canal this species is in agreement with *Tarpon atlanticus* and *Albula vulpes*, and also as to the presence of a large blind sac. However, in the two species mentioned last, the blind sac of the stomach projects backward instead of forward. In the possession of numerous caeca *E. saurus* and *T. atlanticus* agree, and differ from *A. vulpes*, which has only about 13.

The eggs and earliest stages of the leptocephali of *Elops saurus* remain unknown. The youngest larvae, judged principally by the development of the fins, among the

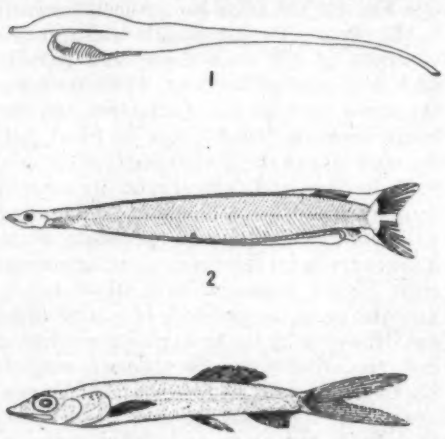
TABLE 1.—FREQUENCY DISTRIBUTION OF GILL RAKERS IN ELOPS SAURUS, E. AFFINIS, AND E. SENEGALENSIS

Species	Upper Limb							Lower limb									
	5	6	7	8	9	10	11	10	11	12	13	14	15	16	17	18	19	20
saurus	5	16	14	14	—	—	—	5	14	15	12	18	3	—	—	—	—	—
affinis	—	—	—	—	—	4	4	—	—	—	—	—	—	2	3	4	7	3
senegalensis	—	2	1	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—

TABLE 2.—FREQUENCY DISTRIBUTION OF SCALES IN LATERAL SERIES IN ELOPS SAURUS, E. AFFINIS, AND E. SENEGALENSIS

Species	Oblique series counted just above lateral line																										
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
saurus	—	—	—	—	—	—	—	—	—	—	—	1	—	2	1	2	2	1	2	1	2	1	1	1	2	—	1	—	1
affinis	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	1	3	2	—	—	1	—	1	—	—	—	—
senegalensis	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

many at hand are, respectively, 34, 35, and 37 mm long. Although these specimens have the forked caudal fin well developed, the other fins remain undifferentiated. These young larvae are also the most strongly compressed, that is, the thinnest and most unsubstantial ones in the collections studied. Two other larvae, although of about the same length, 34.5 and 36.5 mm long, are slightly more advanced, as a thickening within the finfolds indicates the development of the dorsal and anal fins (see Fig. 2).



Figs. 1–3.—*Elops saurus* Linnaeus: 1, Diagram of alimentary canal showing its forward-projecting blind sac with a "comb" of pyloric caeca; 2, leptocephalus, one of the earliest stages known, drawn from a specimen 35 mm long; 3, recently transformed "young adult," drawn from a specimen only 20 mm long. All drawings by Mrs. Alice C. Mullen.

The largest leptocephali seen are, respectively, 42, 42, and 44 mm long. These specimens may represent about the maximum length attained by the larvae. However, the development at any particular length is quite uneven, as already indicated, and more clearly shown subsequently. The development in these large larvae has progressed somewhat further than in those previously mentioned, as the rays in the dorsal and anal fins are somewhat differentiated, the pectoral fins appear as tufts of membrane and the development of pelvic fins is suggested by thickened places in the abdominal wall. A considerably older specimen, "reduced" in length to 27 mm, has the dorsal and anal fins sufficiently developed to permit the enumeration of the rays, and the pectorals show signs of rays, though the pelvics remain undifferentiated. While the body remains strongly compressed, it nevertheless has become more substantial. Other specimens of the same length are more retarded as the dorsal and anal rays are scarcely differentiated.

In all the leptocephalus stages known the head is strongly depressed, and the snout viewed either ventrally or dorsally, is rather sharply triangular. Pigmentation in preserved specimens consist of two series of dark spots running the full length of the abdomen, a row being situated on each side of the alimentary canal, which in this species, as in larval herring and other herring-like fishes studied, is loosely attached to the body.

The smallest young adult, that is, a specimen that has become rather robust, though still more strongly compressed than fully developed adults, with all the fins, except the pelvics, well developed, is only 16 mm long. This specimen represents the maximum shrinkage among the many young studied. The rather numerous young adults in the collections at hand show a wide range in development. For example, a specimen scarcely 20 mm long (see Fig. 3) is fully as well developed as others around 30 mm long. Then, there is a 30-mm specimen in the collection that has advanced fully as far in acquiring characters of the adult as others 35 to 40 mm long. A great difference in development of color also is evident. The 20-mm specimen, already mentioned, has some of the silvery color of the adult, with all the color markings of the leptocephalus missing, whereas some specimens around 30 mm long remain pale, and retain the two series of dark dots on the abdomen of the juveniles already described.

The small, exceptionally advanced specimens were all taken in brackish to nearly fresh water pools and ponds, near the sea, whereas the retarded specimens were taken at sea. The indication, then, is that the environment greatly affects development.

Even though development is not uniform,

it nevertheless may be stated that generally when the leptocephali have become reduced to a length of about 20 mm they are virtually young adults. At that stage the fins, exclusive of the pelvics, are well developed, considerable thickening of the body has taken place, the outline of the gular plate is visible under magnification, and usually general pigmentation is under way. Scales begin to appear at a length of about 50 mm and by that time the teeth in the jaws, which are in a single series in the leptocephali, definitely are in bands. Scalation and pigmentation are complete at a length of 60 to 65 mm, and the young then are very similar to full-grown adults.

The leptocephali of this species evidently do not grow so large as those of *Albula vulpes*, as the longest leptocephalus of *Elops saurus* in the collections studied is only 44 mm long, whereas the largest one of *A. vulpes* has a length of 70 mm, and many others of that species are only slightly shorter. Furthermore, the leptocephali of *A. vulpes* have a rather heavier body. The larvae of the two species are readily distinguishable by the shape of the head. In *E. saurus* the head is rather broad and strongly depressed, and the snout as seen from above or from below is rather sharply triangular. In *A. vulpes* the head is notably narrower, not especially depressed, and the snout is conical. The larvae may be distinguished, also, by the number of myomeres, as *E. saurus* has about 77 to 82, whereas *A. vulpes* has about 66 to 72. When the dorsal and anal fins become sufficiently developed to permit the enumeration of the rays, the species are readily separated by the number of rays, as *E. saurus* has 21 to 25 dorsal and 14 to 17 anal rays, whereas *A. vulpes* has 14 to 17 dorsal, and only 8 or 9 anal rays.

The young of *Tarpon atlanticus* remain largely unknown, only one specimen about 20 mm long (no longer extant) having been described (Hildebrand, Copeia, 1934, No. 1: 45). This specimen was in the transition stage. It was readily distinguishable from both *E. saurus* and *A. vulpes* by the fewer myomeres, of which only 52 were present, and by the short dorsal with 12 rays and the long anal with 20 rays.

The spawning season and the place where *Elops saurus* spawns remain unknown. However, ripe or nearly ripe fish have been found. One female with large roe was caught at Beaufort, N. C., on October 23, and 20 ripe or nearly ripe fish, consisting of 7 males and 13 females, were taken in February on the Canal Zone (Hildebrand, Zoologica 24: 25. 1939). These 20 fish were chosen at random from hundreds that became stranded when the Gatun Locks were dewatered in 1935. As every fish examined, selected from among the many present, contained gonads in an advanced state of development, it perhaps may be assumed that at least most of many hundreds present were gravid fish. It seems proper to conclude, therefore, that at least some spawning takes place during our winter months.

Leptocephali in the various stages of development, already described, were collected at Beaufort, North Carolina, during January, February, March, April, May, October, November, and December. Leptocephali were collected in Texas, mostly at Corpus Christi, in February, March, April, and November. Others were taken in the Florida Keys in November, and in Cuba during May. Young adults, in or just past the transition stage, were collected at Beaufort, N. C., in March, May, June, July, and August; in Aransas Pass, Tex., in June; and at Key West, Fla., in March and November. This wide spread of time over the year of the capture of the young, even in one locality, as at Beaufort, N. C., suggests either that spawning takes place during most of the year or that the development is unequal.

If the slow development of the leptocephali of the fresh-water eels may be used as a criterion, even the youngest leptocephali of *Elops saurus* described may be several months old. Also, if the life history is similar to that of the eels the youngest larvae of *Elops saurus* at hand may have been captured far from the place of their birth. It apparently may be stated with some degree of certainty that the early stages of the leptocephali do not occur in the shallower waters in the vicinity of Beaufort, N. C., where more or less advanced stages de-

scribed herein are moderately common. In that vicinity intensive collecting with several types of gear, was carried on during every month over a period of many years in the inshore waters and to a somewhat lesser extent offshore to a depth of about 12 fathoms. The suggestion that spawning probably takes place far offshore presents itself.

Although no gravid examples of *Albula vulpes* were seen, the leptocephali and young adults were taken somewhere along the Atlantic and in the West Indies between Beaufort, N. C., and Panama, virtually throughout the year (collections for October and December only being missing). Many leptocephali and young adults of this species from the Pacific coast of Panama and a few from Colombia taken during February, March, and "autumn" also have been examined. Therefore, the remarks as to spawning made in the preceding pages probably apply equally as well to this species as to *Elops saurus*.

PROCEEDINGS OF THE ACADEMY

380TH MEETING OF THE BOARD OF MANAGERS

The 380th meeting of the Board of Managers was held in the library of the Cosmos Club on January 11, 1943. President CURTIS called the meeting to order at 8:05 P.M., with 19 persons present, as follows: H. L. CURTIS, F. D. ROSSINI, H. S. RAPPLEYE, N. R. SMITH, R. J. SEEGER, J. E. GRAF, F. G. BRICKWEDDE, F. C. KRACEK, A. WETMORE, J. E. MCMURTREY, JR., W. A. DAYTON, W. RAMBERG, E. W. PRICE, L. W. PARR, C. L. GARNER, H. G. DORSEY, and by invitation G. A. COOPER, A. SEIDELL, and L. V. JUDSON.

The minutes of the 379th meeting were read and approved.

President CURTIS announced appointment of the following committee to obtain more subscriptions of the JOURNAL from Government bureaus: F. G. BRICKWEDDE (chairman), W. W. DIEHL, and F. H. H. ROBERTS, JR.

For the Committee on Membership, Chairman KRACEK presented nominations of 12 persons (11 resident and 1 nonresident).

The Committees on Awards for Scientific Achievement for 1942, ALEXANDER WETMORE, general chairman and chairman of the Committee for the Biological Sciences, H. N. EATON, chairman of the Committee for the Engineering Sciences, and L. V. JUDSON, chairman of the Committee for the Physical Sciences, presented the names of three candidates for the awards, which were approved by the Board for announcement at the annual meeting of the academy.

The Secretary reported three deaths, three resignations, and three retirements.

The Board authorized the President to appoint a Committee on the A.A.A.S. Research Grant for 1943, which will amount to $150 for the Academy.

The meeting adjourned at 9:27 P.M.

FREDERICK D. ROSSINI, *Secretary*.

Obituaries

The death on July 13, 1942, of HENRY GRANGER KNIGHT, chief of the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, marked the passing of one of the most notable and interesting figures among American agricultural chemists. His 16 years as director of three widely separated State experiment stations and his 15 years as chief of a Federal bureau gave him an administrative experience in agricultural chemistry that has few parallels in the history of American science.

Knight was born on July 21, 1878, at Bennington, Kans., on a prairie farm, from which his parents moved a few years later to Port Townsend on Puget Sound. He entered Washington State University at Seattle where he earned his way by various activities. After obtaining his A.B. degree at Washington in 1902, he spent one year as student and assistant in chemistry at Chicago University, and then returned to Washington as Assistant Professor of Chemistry.

In 1904 Knight accepted the double appointment of professor of chemistry and State chemist at the University of Wyoming, the duties of which he resigned in 1910 to accept the directorship of the Wyoming Agricultural Experiment Station. His administrative duties were further increased in 1911, when he was appointed dean of the Wyoming College of Agriculture. While at Wyoming Knight published

four bulletins on the chemical composition of Wyoming forage plants; he wrote bulletins also on the death camass and woody aster, plants poisonous to livestock. In 1916–17 he did postgraduate work at the University of Illinois for which he obtained his Ph.D. degree for a thesis on acidity and acidimetry of soils. In 1918 Knight resigned his position in Wyoming to accept the directorship of the Oklahoma Experiment Station and the deanship of its school of agriculture. Political disturbances caused him to resign this position in 1921. After a year's postgraduate study at Cornell University as honorary fellow, Knight accepted a call to the University of West Virginia as director of its experiment station and in 1926 as dean of its school of agriculture.

In 1927, when the U. S. Bureau of Soils and the Fixed Nitrogen Laboratory were merged with the research work of the Bureau of Chemistry, direction of the newly constituted Bureau of Chemistry and Soils was awarded to Dr. Knight, who had the courage to accept what lack of homogeneity had caused others to decline. Although he strove valiantly toward welding a discordant collection of activities into a unified bureau, the task was an impossible one, the result being transfer of the soils, fertilizer, and insecticides work to other bureaus. These losses, although discouraging, were more than counterbalanced by Knight's acquiring direction of four new regional research laboratories. It was while giving his last depleted resources of mind and body to organizing these laboratories for the needs of war that Henry G. Knight paid the inevitable price.

Dr. Knight preferred to be recognized more as an organizer and administrator of research than as an actual contributor to science. His extensive experience as a director of State experiment stations helped greatly toward establishing more cordial relations between these institutions and the Federal Department of Agriculture. The extent of his influence within the Department of Agriculture is indicated by his membership in 12 intradepartmental committees. From 1930 to 1942 he served as chairman of the Editorial Committee for the Journal of Agricultural Research. He was president of the American Institute of Chemists in 1933–35, and in May 1941 received from Vice-President Wallace the Institute's gold medal for outstanding accomplishments in agricultural chemistry. Temperamentally he was a man of jovial disposition who will long be held in affectionate remembrance by a host of friends.

C. A. BROWNE.

THOMAS LEONARD WALKER, who died on August 6, 1942, was born near Brampton, Ontario, on December 30, 1867, of English parentage. His father, William Walker, was a native of Whitby, England, while his mother, Hannah Sanderson Walker, came from Scarborough, England. He attended schools in both Brampton and Orangeville, Ontario, and then entered Queen's University, Kingston, from which he received the silver medal in chemistry and the degree of master of arts in 1890, and at a later period the Gowan Prize in botany.

For a short time after his graduation from Queen's University he was employed as chemist at the Murray Mine, and for two years was laboratory demonstrator in the Faculty of Mines, Queen's University. He was awarded one of the first 1851 Exhibition Scholarships and continued his studies under Prof. F. Zirkel in the University of Leipzig, where, in 1896, he was awarded the degree doctor of philosophy. At a later time he also continued his studies in crystallography in the University of Heidelberg with Prof. Victor Goldschmidt.

In 1897 Dr. Walker was appointed assistant superintendent of the Geological Survey of India. While in India he made a scientific expedition across the high passes of the Himalayas into Tibet, making incidentally a collection of Himalayan mosses, many of which were new to science.

In 1901 he returned to Canada to become professor of mineralogy and petrography in the University of Toronto, a position that he held until his retirement in 1937. In 1913 the Royal Ontario Museum of Mineralogy, Toronto, appointed him its first director. Through the years Dr. Walker worked indefatigably for the Museum. By collecting, judicious purchase, and exchange he built up a Museum of Mineralogy that ranks among the best seven in the world.

Dr. Walker was one of the founders and the first vice-president of the Mineralogical Society of America, in 1920, and president in 1922. He was a fellow of the Geological Society of

America (1903) and vice-president (1922 and 1931). He was made an honorary member of the Mineralogical Society of Great Britain and Ireland in 1937 after being an ordinary member since 1913. He was a fellow of the Royal Society of Canada (1919) and president of Section IV (Geological Sciences) 1927–28; a fellow of the Geological Society of London; fellow of the Royal Geological Society of Cornwall; member of the Canadian Institute of Mining and Metallurgy; and a member of this Society. For many years he was a member of the committee on the measurement of geologic time in the National Research Council (United States).

He was an indefatigable worker and accomplished much that was worth while. His thesis for the doctorate started an intensive study of the conditions governing the deposition of the nickel-copper ores of the Sudbury basin. His reports on the tungsten and molybdenum ores of Canada called attention to materials that have become of great importance. He was one of the pioneers in the use of the 2-circle goniometer on this continent and wrote his Crystallography to make this method more readily available in the English language.

The mineral temiskamite, almost simultaneously described under the name maucherite, which was described by him, was the cause of much dispute as to its true composition. The latest examination by means of X-rays agrees within reasonable limits with the composition as given by Walker, although the name maucherite is preserved as having prioity in publication. Other minerals that were described by him are spencerite, chapmanite, schoepite, enelectrite, and, in collaboration with the writer, ellsworthite.

In view of the limited facilities for publishing in English articles dealing with mineralogy and petrography Dr. Walker started the series of "Contributions to Canadian Mineralogy from the Department of Mineralogy and Petrography in the University of Toronto" in 1921. This publication has appeared annually since that time, except for the year 1936, when he was stricken with his fatal illness. It was then deferred until the next year when a double number was issued.

Special recognition was given to the accomplishments of Dr. Walker in 1938 when the University of Toronto granted him the degree doctor of science (honoris causa), and in 1941 the Royal Society of Canada conferred him further honor by the bestowal of the Flavelle Medal for his important contributions to mineralogical science.

He traveled widely and was a member of nearly every International Geological Congress during his academic career, and on each occasion he brought home material to enrich the collections of the University and of the Royal Ontario Museum of Mineralogy.

Dr. Walker will be remembered because of the men he trained. He will also be long remembered as the builder of a great mineral museum. To these great objectives he devoted his life, and his accomplishments were of no mean order.

In 1906 Dr. Walker married Mary Augusta Woods, daughter of the late Sir James Woods, of Toronto. He is survived by his wife and also by two sons, James Woods Walker and William P. Walker, and one daughter, Euphemia B. Walker.

A. L. PARSONS.